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Science Technical Review of the draft Environmental Impact Statement (EIS) for Baffinland's Mary River Project

Examen scientifique de l'ébauche d'étude d'impact environnemental (EIE) du projet de Mary River soumis par Baffinland.

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ABSTRACT

Baffinland's Mary River Project is a proposed iron ore mining operation located in the Canadian Arctic on northern Baffin Island, Nunavut. The Project includes port developments proposed in Steensby and Milne inlets, an all weather road from the Milne Inlet Port to the mine, a year-round railroad line from the Steensby Port to the mine and a year-round shipping route through Foxe Basin and Hudson Strait. Since 2005, Baffinland has conducted baseline studies which form the basis of their draft Environmental Impact Statement (EIS) for the Mary River Project. These studies cover the terrestrial, freshwater, atmospheric and marine environments, as well as socio-economic conditions and land use. Baffinland submitted the draft EIS for development of the Mary River Project to the Nunavut Impact Review Board (NIRB) for detailed environmental and socio-economic review. Fisheries and Oceans Canada (DFO) is responsible for conducting a technical review of the draft EIS. To that end, Ecosystems Management sector within Central and Arctic Region requested advice from the Science sector to assist them with reviewing the Baffinland draft EIS, especially the potential impacts of ice-breaking/shipping activities on marine mammals.

DFO Science staff that reviewed the draft EIS identified a number of unresolved issues in the report. These concerns relate to the alternative assessment of port locations, extent of the local study area, shipping routes, transboundary issues, baseline studies, valued ecosystem components, environmental impacts/effects assessment, noise, and ballast water. The reviewers concluded that there are several shortcomings in data collection, analysis and interpretation in the draft EIS. As a result, the draft EIS does not contain sufficient information to support the Proponent's conclusions about Project effects on the marine environment, including marine mammals.

RÉSUMÉ

Le projet de Mary River a pour but d'exploiter le gisement de fer situé à Mary River, au nord de l'île de Baffin, au Nunavut, dans l'Arctique canadien. Le projet comprend des aménagements portuaires dans les bras de mer Milne et Steensby, une route toute saison entre l'installation portuaire du bras Milne et la mine, une voie ferrée permanente entre l'installation portuaire du bras Steensby et la mine et une voie navigable à l'année traversant le bassin Foxe et le détroit d'Hudson. Depuis 2005, Baffinland effectue des études préliminaires qui constituent le fondement de l'ébauche d'étude d'impact environnemental (EIE) de la société pour le projet de Mary River. Ces études portent sur les environnements terrestre, d'eau douce, atmosphérique et marin ainsi que sur les conditions socio-économiques et l'utilisation des terres. L'ébauche de l'EIE de Baffinland a été transmise à la Commission du Nunavut chargée de l'examen des répercussions (CNER) pour un examen environnemental et socio-économique détaillé. Pêches et Océans Canada (MPO) doit pour sa part effectuer un examen technique de l'ébauche de l'EIE. À cette fin, le secteur de la Gestion des pêches de la Région du Centre et de l'Arctique de Pêches et Océans Canada (MPO) a demandé au secteur des Sciences de formuler un avis pour l'aider à passer en revue l'EIE de Baffinland, particulièrement en ce qui concerne les impacts potentiels du déglaçage/transport maritime sur les mammifères marins.

Le personnel des Sciences du MPO a relevé un certain nombre de questions non résolues dans l'ébauche de l'EIE. Ces questions concernent l'évaluation des des alternatives quant à l'emplacement des installations portuaires, l'étendue de la zone à l'étude, les voies de navigation, les enjeux transfrontaliers, les études de base, les composantes de l'écosystème mises en valeur, l'évaluation des impacts et des effets environnementaux, le bruit et les eaux de ballast. Les examinateurs ont conclu que l'ébauche de l'EIE affichait plusieurs lacunes en matière de collecte, d'analyse et d'interprétation des données. En conséquence, l'information présentée dans l'ébauche de l'EIE est insuffisante pour soutenir les conclusions du promoteur concernant les effets du projet sur l'environnement marin, y compris sur les mammifères marins.

INTRODUCTION

The Mary River Project is a proposed iron ore mining operation. The mine itself will be located in the Canadian Arctic on northern Baffin Island, Nunavut (Fig. 1). At the draft Environmental Impact Statement (EIS) stage, the Project includes port development proposed for Steensby and Milne inlets, an all-weather road from the Milne Inlet Port to the mine, a year-round railroad line from the Steensby Port to the mine and a year-round shipping route through Foxe Basin and Hudson Strait. Following the initial submission of the draft EIS, the function of the Milne Port was changed. It will only be used periodically during the open-water season to receive oversized equipment and materials and it will not be used to ship iron ore.

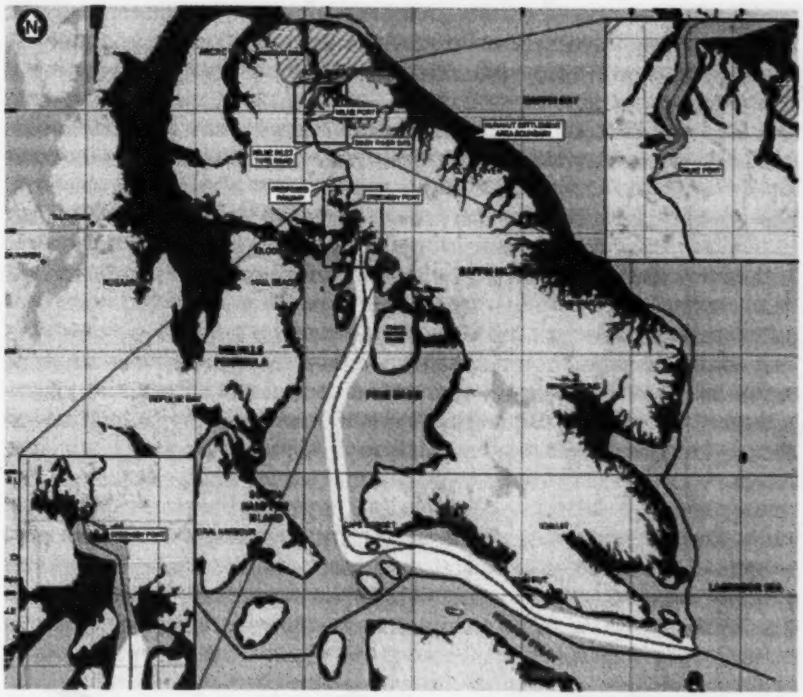

Fig. 1. Mary River Mine Project location. (from Baffinland draft EIS Fig. 1-1.1)

Baffinland Iron Mines Corporation (Baffinland) prepared the draft EIS for development of the Mary River Project. The draft EIS was submitted to the Nunavut Impact Review Board (NIRB) for detailed environmental and socio-economic review on 21 January 2011. NIRB assessed the submission for conformity with their EIS guidelines. On 15 February 2011 the NIRB initiated the technical review process beginning with the submission of Information Requests (IRs) to NIRB by 17 March 2011. The IR phase is meant to identify gaps within the draft EIS that need to be addressed so that parties can undertake their technical reviews. DFO Science staff met to discuss IRs on 7 March 2011 which were considered by DFO Habitat Management as part of the DFO submission. Baffinland responded to some of the IRs and met with various interested parties up to the end of July 2011 to discuss concerns. Meanwhile, on 5 July 2011 NIRB initiated the Technical Review phase of the process with a submission date for the technical review comments of 5 September 2011. The Qikiqtani Inuit Association (QIA) requested and was granted a one-month extension to the technical review period. As a result all submissions were due to NIRB by 5 October 2011. Baffinland continued to respond to IRs until 27 September 2011.

The Proponent, Baffinland Iron Mines Corporation, has changed ownership since the draft EIS was originally submitted to the NIRB. It is now 70% owned by ArcelorMittal and 30% by Iron Ore Holdings, LP. Baffinland Iron Mines Corporation is now private. ArcelorMittal is the largest steel company in the world, producing 8 percent of the world's steel output.

TECHNICAL REVIEW

This review was conducted by DFO Science staff between 5 July 2011 and 27 September 2011 based on material made available in time to be included, and was limited by time constraints and available expertise. It focuses primarily on potential impacts of the Project on marine mammals especially along the Foxe Basin/Hudson Strait shipping route. Comments on the general presentation of the draft EIS are included in response to specific NIRB guidelines. Additional information is provided in endnotes and identified by numbered superscripts (^{n}) in the main body of the document.

OVERVIEW

DFO Science staff have identified a number of issues related to the draft EIS that were also identified as areas of common concern during discussions with other jurisdictions reviewing the draft EIS. These concerns relate to the following topics: ballast water, transboundary issues, valued ecosystem components, baseline studies, environmental impacts/effects assessment, proposed mitigation, shipping routes, noise and alternative assessment of port locations and are covered in this technical review.

This review argues against the Proponent's conclusion of negligible significance of residual impacts on marine mammals for a port built in Steensby Inlet and massive ice-breaking ore carriers passing through Foxe Basin and Hudson Strait year-round. The authors of this Research Document will demonstrate that in the draft EIS the Proponent is unable to make predictions about the extent of potential impacts on marine mammals or to monitor adequately effects or future changes, and that the Proponent has not outlined means to mitigate these effects or restore habitat quality once the Project is underway or completed. We will also identify how criteria for cumulative impacts assessment used in this draft EIS are fundamentally flawed, how major components of potential impacts, such as oil spills in ice and noise effects, were evaluated inadequately, and how additional work is required to support the claims made in the draft EIS. Finally, we will demonstrate how the assessment of port sites was too limited and offer reasons why further efforts should be directed towards an improved assessment of an eastern Baffin Island port option.

ALTERNATIVES ASSESSMENT

Port Location

Source(s): Revised (Rev.) Volume (Vol.) 3 – Updated Project Description (Addendum, June 2011), Section (S.) 6.5.3; Vol. 8; Appendix (App.) 3F-1 (Enfotec 2010).

Proponent's Conclusions:
Alternative ports were considered and evaluated according to a series of criteria (technical feasibility, cost implication in terms of implementation, potential impacts to the environment, community acceptability or preference, enhancing socio-economic effects and amenability to reclamation) and a ranking method (Rev. Vol. 3, S. 6.4: 122-124). A table of scores was presented (Rev. Vol. 3 Table 3-6.1:125-128). Steensby Inlet was identified as the preferred site

as a result of *"significantly more difficult ice conditions at the North Baffin sites at present and in the future"* (Rev. Vol. 3, Table 3-6.1: 126, App. 3F-1:v).

DFO Science Reviewer's Conclusions and Recommendations:
Rejection of an eastern Baffin port at this stage is not supported by the information and the methods applied by the Proponent. In fact, the Proponent provides sufficient information to conclude that the dismissal of an eastern Baffin Island port was premature. Considering the anticipated non-negligible impacts of a port in Foxe Basin on the marine environment and marine mammals (see below), and the much lower environmental impacts anticipated for an east Baffin port (see below), the authors of this Research Document recommend that the Proponent undertake a re-evaluation of an eastern Baffin port option (such as Port "F" in App. 3F-2), taking care to apply the same criteria values as similar options elsewhere and considering the impacts on marine mammals. The authors of this Research Document also recommend that lower latitude locations not examined so far, and ships with modern alternate designs more appropriate for an eastern Baffin port (possibly PC 3 or PC 2), be included in the re-evaluation.

The reasons for this determination are provided below.

On the basis of applying the Proponent's impact definitions as they said they would be applied, the authors of this Research Document conclude that the overall score for an eastern Baffin port option would be "9". This value is greater than that currently attributed by the Proponent to the Steensby port option which they ranked highest.

The evaluation of alternate ports was flawed. There were errors and inconsistencies in how the criteria were applied in the draft EIS. For example, the criteria used to assess Cost Implication identified the Steensby Inlet port as the preferred site (rating=2) and acceptable equivalents were rated as 1, biasing the scores in favour of the already selected option. The word definitions indicate scores 1 and 2 are the same, although *"2" "is the preferred alternative"*. (Rev. Vol. 3:123).

A problem also exists with another criterion. Superficially, the assessment of Potential Impacts to the Environment also appears to be a valid comparison: "... *expected severity of residual effects on the environment: "2" represents the alternative that has the least impact on the environment without mitigation; "1" represents an acceptable alternative which minimizes adverse impacts to the environment with mitigation;* (Rev. Vol. 3:123). Because "least" = minimum, the ranking clearly hinges on the requirement for mitigation. But the draft EIS makes it clear that virtually no aspect of the Project is without mitigation therefore none of the sites warrants a rank of 2 because none is without mitigation[2].

Eastern Baffin port sites would score even higher relative to the Steensby option if a more appropriate score was assigned to both options for Technical Feasibility (TF). Specifically, eastern Baffin port sites option scored "0" on the basis of "*not technically viable*". "Viable" was not presented as an environmental assessment criterion and as such this cell deserves a score of "1" as was assigned for the "*feasible but not viable*" assessment for Milne Inlet. Given the doubts about the biological feasibility of the nominal shipping route, Steensby Inlet should likely get a score of "1" also. Providing an overall rank of "0" for eastern Baffin ports on the basis of "*technically not feasible*" is not supported by the TF assessment in the Table or the text: "*Shipping through Baffin Bay to the east coast port sites would require at least a Polar Class of PC 3, but more likely a PC 2.*" (Rev. Vol. 3:140). Clearly then, the eastern Baffin port option is feasible if the Proponent utilizes suitable ships. Enfotec cites examples of *M.V. Arctic's* capabilities as a nominal PC 4 but not those of the more powerful *M.V. Umiak II*, built 5 years ago (Fednav 2011). The cape-size ore carriers proposed do not yet exist, and modern alternate designs more appropriate for an eastern Baffin port have not been presented in this draft EIS. The authors of this Research Document assume that there must be a range of ice capability and size options between *Umiak*'s 31,500 DWT and the proposed 190,000 DWT cape-class ore carriers. Some of these alternate vessel choices may also be more manoeuvrable, which would address a concern raised both for the Foxe Basin and eastern Baffin port options. Failure to include alternate vessel designs suggests the Proponent has committed to a ship design that prejudges the selection of an alternate port, contravening NIRB guidelines (NIRB Guide 7, 2006, p. 5).

In terms of cost, an eastern Baffin alternative was assigned a value of "1" because it was no more costly than Steensby Inlet. However, if the two ports are equivalent in cost (i.e., no disadvantage) they should receive the same score ("2"). From the perspective of an environmental assessment, economic feasibility is less relevant than environmental costs yet there appears to be no cost analysis for potential compensation due to impacts on living resources. Based on the area impacted alone, one might conclude that the eastern Baffin port would have lower compensation costs. The fact that marine mammals would have more escape routes, that fewer species occur in sizeable numbers, and that overall marine mammal abundance would be lower, means it is reasonable to expect the marine environmental impact would likely not exceed that of the southern route, and that it could be much smaller.

But for the authors of this Research Document, the claim that the environmental impact of an eastern Baffin port is "*Not a significantly greater environmental footprint compared with route to Steensby Port*" is undoubtedly true. "*Railway routes to the two east coast port alternatives are only slightly longer and higher cost than the Steensby Port base case for the Project (App. 3F-2).*" (Rev. Vol. 3:132) so there is no reason to expect greater terrestrial or freshwater impacts but this was not examined in the draft EIS. In our opinion, an eastern Baffin port would have a smaller footprint, at least in the marine environment. A route from eastern Baffin ports to the tip of Greenland, which would travel down the eastern coast of Baffin Island to parallel and avoid the pressure ridging further off that coast, would be about 2,200 km in length, which is virtually the same as the distance to Steensby Inlet (2,400 km). Ships leaving from an eastern Baffin port would be in Canadian waters for approximately 135 km, instead of 1,500 km as they would for the Steensby Inlet option. In this case, the Canadian marine environmental footprint is therefore substantially less for an eastern Baffin port option. In our opinion the latter should therefore be afforded a score of "2" (*least impact*) and not "1". Using 1.5 km as the nominal shipping route width (Vol. 8:243) and 250 km as the detectable noise radius (Vol. 8:177), the potential environmental noise impacts footprint for an eastern Baffin port option (135 × 1.5 km to 135 × 250 km) would be 200 to 33,750 km^2 compared to (1,500 × 1.5 km, 1,500 × 250 km) 2,250 to 375,000 km^2 for the Steensby option. An eastern Baffin port impacts <10% of the regional study area (RSA) impacted by a Foxe Basin port option, and should be considered a "significant improvement" using the Proponent's 10% rule.

Information contradictory to the Proponent's stated preference was not considered in the alternative ports assessment. Enfotec acknowledges that climate change may lead to different ice regimes, but assumes that these changes will apply in a uniform manner to all of the study sites being examined (App. 3F-1:41). This may not be the case: in 2011, reduced sea ice extent (Fig. 2, NSIDC 2011) appears to favour northern ports more than the Foxe Basin option.

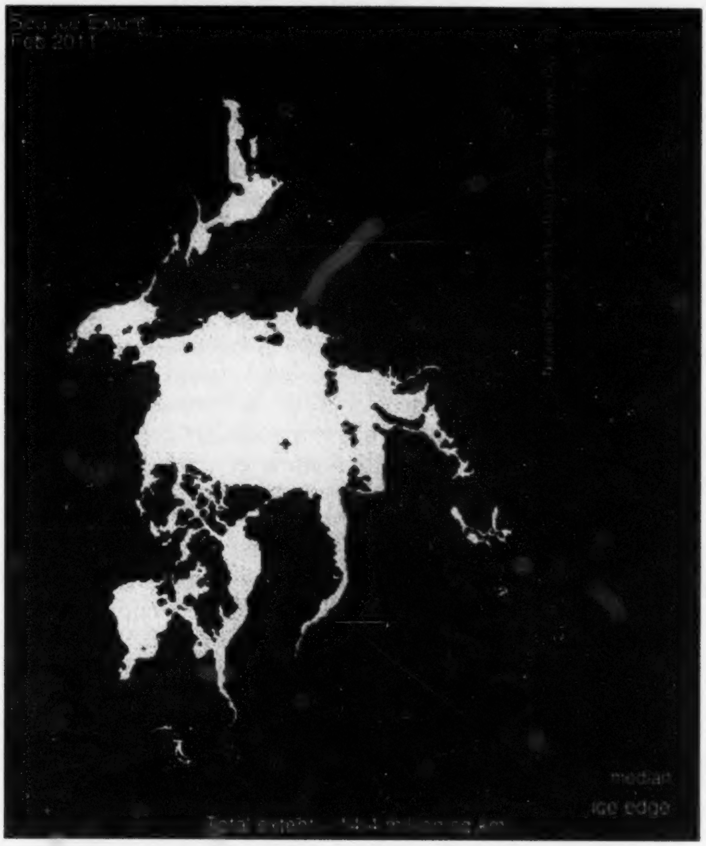

Fig. 2. Arctic sea ice extent for February 2011 was 14.36 million square km (5.54 million square miles). The magenta line shows the 1979 to 2000 median extent for that month (from National Snow and Ice Data Center).

Conversely, while freeze-up was delayed 6-8 weeks in Hudson Bay and Hudson Strait, and ice cover in January 2011 was 36% of normal in Hudson Strait, Davis Strait and the northern Labrador Sea, it was only about two weeks late and reached 60% of average cover in Baffin Bay and Davis Strait, although there was virtually no ice in eastern Baffin Bay (EC 2011). Average thickness of ice deviated below average more in southern areas than Baffin Bay (EC 2011). Not only may the ice coverage data from 1992 presented in App. 3F-1 be irrelevant now, but regional differences in changing ice regimes need to be considered. "*So, the project will need to ensure decisions taken today consider the long-term affects of possible and or likely changes to the ice conditions along the different routes and port sites.*" (App. 3F-1:41)

Given decadal reductions in ice coverage and thickness (EC 2011, NSIDC 2011), the analyses should use data from the same decades, and include the most recent years. The images illustrating northern ice conditions (Figs 8-13) span 1986 to 1999 and those illustrating access to Steensby (Figs 17,19,20,23-28) span 2003 to 2008, without discussion (App. 3F-1).

Eastern Baffin sites were lumped with Milne Inlet and Pond Inlet as "North Baffin" sites (App. 3F-1, S. 1.2.1). Although the ice regime zone is different for eastern Baffin Island (Zone 9, Fig. 29), Table 5 assessed just Zone 13, relevant only to Milne and Pond inlets (p. 38). They are not necessarily the same, as evidenced by the slightly longer port entry seasons in Zone 9 than

Zone 13 (e.g., for AC4 - Zone 9: 265 days, Zone 13: 258 days, TC 2011). S. 4.1 and 4.3, which present conclusions about northern ports and compare North Baffin and Steensby Ports, make no mention of eastern Baffin options except perhaps Conclusion # 2 which says, in part, "*If a site were to be selected within Zone 9, the shipping season for Baltic Class vessels would be further reduced by about three weeks.*" (p. 42). This appears at odds with the TC table of entry dates. Lumping eastern Baffin options with northern Baffin options is unwarranted.

Given the potential reduction in environmental impacts for marine fauna related to noise and ice habitat disruption caused by large ore carrier transits, the authors of this Research Document maintain that the Proponent should consider alternative ports at lower latitudes, e.g., closer to Clyde River, where terrain elevation at port sites are appropriate and fjords are not as narrow. The choice of a port site with minimal environmental impacts is particularly crucial in the context of the anticipated increase in production and eventual exploitation of other ore deposits, as it will lead to further increase in icebreaker transits and will exacerbate environmental impacts. Further, since the eastern coast port site options are within fjord systems, it is highly likely that the area of underwater ensonification during construction, operation, and decommissioning of a port in one of these locations will be smaller than the Steensby Inlet site (which is more open).

The authors of this Research Document have concerns that, with removal of Milne Port as an option for ore shipment point, there will be less incentive to consider operation of an ore shipment point on the eastern coast of Baffin Island. Further, although the Proponent considers that the environmental impacts for the Project are "reduced" with elimination of Milne site ore shipments, will this ore shipment capacity (upon which we presume the Project viability was calculated) not then be transferred to what we consider to be the more environmentally sensitive Steensby Site, and in effect have greater impacts? Our analysis of the draft EIS port site assessment is based on a stated cap of 18 Mt/yr for shipments made from the Steensby Inlet Port. Increased production could likely result in more favourable assessment of eastern Baffin ports relative to the Steensby Inlet option.

Based on available information, the authors of this Research Document expect lesser effects on marine mammals associated with the eastern Baffin port option. If railway construction costs are equivalent and marine environmental "costs" in Canadian waters are only 10% of the Foxe Basin/Hudson Strait option (because the footprint is only about 10% going from eastern Baffin), it points to an eastern Baffin port option as a convincing alternative. Add to that, most of the eastern Baffin region is occupied only seasonally by beluga, narwhal, and bowhead whales, and walrus are less abundant there than in Foxe Basin. Even if the eastern Baffin port choice impacted all ringed and bearded seals in the area, it would impact significantly fewer marine mammals than in the currently proposed location.

The authors of this Research Document recommend that the Proponent undertake a re-evaluation of the eastern Baffin port option (such as Port "F" in App. 3F-2), taking care to apply the same criteria values as similar options elsewhere and considering the impacts on marine mammals. We also recommend that lower latitude locations not examined so far, and ships with modern alternate designs more appropriate for an eastern Baffin port (possibly PC 3 or PC 2), be included in the re-evaluation. As stated previously, such evaluations should not be based solely or primarily on economic factors, but rather the potential to reduce the environmental impacts of the proposed project.

Shipping Route

Source(s): Rev. Vol. 3, S. 6.5.10.1 (Shipping Route through Foxe Basin);
Vol. 8, App. 8A-1; IR response to DFO; CD of bathymetry; Enfotec 2010.

Proponent's Conclusions:

1. Two shipping corridors were assessed through northern Foxe Basin into Steensby Inlet. Ships will pass through southern Foxe Basin following established shipping lanes. In northern Foxe Basin, ships will pass either to the west (Option A) or the east (Option B) of the Spicer Islands, Rowley Island and Koch Island. The eastern route (B) is the preferred alternative, as it is considered less intrusive to local land users.

2. Two shipping corridors were assessed through western Hudson Strait. Ships will either pass north of Mill Island (Option C) or between Mill Island and Salisbury Island (Option D). Baffinland agreed to use option D to the extent possible, in keeping with the request from the community of Cape Dorset, except when ice conditions are very poor.

3. The shipping route is identified in Fig. 8-1.1 (Att_13_Rev. draft EIS Shipping figures). It has been studied and approved by the experts from the company intended to operate the ships[redacted]. However based on the draft EIS, ships are not expected to adhere to the illustrated routes[redacted].

4. *"Hudson Strait is an established shipping route used by other ships and sea lifts travelling toward and from the Port of Churchill. As a result of the close proximity of the majority of travel routes in South Baffin to the coastline an effect on travel routes is not anticipated."* (Vol.4:168)

DFO Science Reviewer's Conclusions and Recommendations:

1. Considering the anticipated non-negligible impacts of a port in Foxe Basin on the marine environment and marine mammals, and the much lower environmental impacts anticipated for an east Baffin port, the authors of this Research Document recommend that the Proponent undertake a re-evaluation of an eastern Baffin port option and associated shipping routes. Notwithstanding that recommendation, we agree that the eastern route (Option B) within Foxe Basin is preferred over the western route (Option A) to reduce disturbance to important marine mammals and their habitat.

2. The draft EIS does not provide sufficient information about marine mammal distribution and abundance to evaluate impacts of shipping route options C and D in western Hudson Strait. Information on walrus distribution indicates option C might be preferred. However, published tracking results for beluga (western Hudson Bay population) (Smith 2006; Smith et al. 2007), narwhal (Northern Hudson Bay population) (Westdal et al. 2010) and bowhead whales (Ferguson et al. 2010) indicate that both routes are used during migration and/or wintering.

3. There is some uncertainty as to where ships will actually travel en route to and from the port locations thus the probable extent of area impacted by shipping is unknown. Based on the draft EIS, ore carriers may not adhere to the nominal route identified and there seems to be sufficient impediments to remaining on the nominal route that it is possible more transits will deviate than adhere to the identified route. So, the shipping route is defined but necessarily flexible and significant deviations from the illustrated route are planned, but were not evaluated in the draft EIS. No impact assessment of the "route" can be conducted until the frequency of deviations from "nominal" and their probable locations can be examined. Given weather and ice are the main determinants of whether the nominal route is safe, the frequency and degree of diverging from the nominal route should be modelled. Groundings were dismissed on the basis that ships in the designated corridor would not ground (details presented in Impacts of Shipping – Oil Spills). Given that there is an expectation that some shipping will occur outside the designated route, the risk assessment of groundings should be revisited.

Bathymetric data provided to the authors of this Research Document by Baffinland clearly supports Furgo's cautionary note that many shoals along the nominal route, including the portion of the route near the mouth of Steensby Inlet, are significantly less than 25 m which is too shallow to allow a loaded ore carrier passage. Enfotec (2010:43) concluded that although the Proponent preferred the eastern route in Foxe Basin "*... this route will require more maneuvering. The effect of this may be increased rubble in the vessel track in the area of turns and course alterations. Transit times in the periods of heaviest ice conditions may be adversely affected due to the additional maneuvering. Although the planned vessels will no doubt be able to contend with conditions along either route, from a planning point of view, it is always preferable not to restrict the navigators' options*".

4. The draft EIS states that *"The shipping route from the North Atlantic Ocean to Steensby Inlet extends along established shipping routes through Hudson Strait..."* (Vol. 3:143) Yet elsewhere in the draft EIS it shows the *"existing shipping route"* lies at or to the south of the southern boundary of the *"maximum extent of year-round project shipping route."* (Vol. 9, Fig. 9-1.2) It also states that *"Ships passing through Hudson Strait will remain within the Nunavut Settlement Area (NSA) and are not expected to pass through the Nunavik Marine Region of Northern Quebec or the area of shared Nunavut-Nunavik occupancy, under normal circumstances"* (Vol.1:156). Thus, it would appear the Baffinland ore carriers will not travel along established shipping routes except that *"Baffinland acknowledges that in rare circumstances depending on ice conditions, icebreaking ships may have to navigate Hudson Strait using a more southerly route for safety purposes..."* (Vol.9:95) The draft EIS suggests that icebreaking activities in Hudson Strait would not impact marine mammals because *"the MV Arctic has been providing winter ore transport through Hudson Strait to support mining operations at the Raglan Mine located at Deception Bay in northern Quebec for a number of years. During that time no adverse effects on marine mammals have been documented."* (Vol. 9:96) However, between 2005 and 2008 the number of ships arriving at Deception Bay for the Raglan Mine only numbered between 4 and 9 per year. The authors of this Research Document conclude that the size and frequency of ore carriers that would travel through Hudson Strait and Foxe Basin for the Mary River Project would vastly exceed any current shipping activities in Nunavut or Nunavik. Moreover, the existing southerly routes avoid the biologically sensitive polynyas off the south coast of Baffin Island. For this reason, the impacts of shipping in Hudson Strait on marine mammals should be thoroughly assessed.

In summary, it is clear that shipping is likely to occur west of Koch, Rowley, and the Spicer islands, as well as north of Mill Island at the western end of Hudson Strait and in Nunavik waters. Given most of these shipping routes are new, not existing, and the scope of proposed shipping activity is significantly greater than current levels, the authors of this Research Document recommend that the Proponent provide an impact assessment for all probable shipping routes.

PROPONENT'S ASSESSMENT METHODS

The authors of this Research Document relied on the material and references provided by the Proponent to assess the draft EIS evaluation methods.

Scope of Assessment

Source(s): Vol. 2; Vol. 8; Att_13_Rev. draft EIS Shipping Figures.pdf = Fig. 8-2.2 (Rev.)

Proponent's Conclusions:
Spatial boundaries of the Project were defined by the anticipated zone of influence (ZOI) of Project effects (Vol. 2:31)[redacted]. Thus, the Proponent's position is as follows:

1. the area to be examined for impacts is the area where the Proponent says there may be impacts;

2. the LSA appears to be restricted to Nunavut;

3. LSAs will be defined for each biophysical environmental component;

4. the RSA includes trans-boundary effects and ends at the Nunavut border; and

5. RSA considerations will generally be more qualitative than quantitative.

DFO Science Reviewer's Conclusions and Recommendations:
In our opinion, the qualitative definition of LSA is circular and biased and, since it is based on the extent of expected impacts, can not rationally be used to exclude non-Nunavut waters. Quantitatively, the presentation of LSA is so ambiguous and contradictory that reviewers can not know, with certainty, what area is being used in the various calculations. It is therefore not possible to evaluate the Proponent's assessment. LSAs are not applied to each biophysical environmental component as stated by the Proponent.

1. It is scientifically invalid to define an area based on the (unknown) effects (impacts) to be investigated when part of that investigation is to determine what areas are impacted. It biases the assessment so impacts are only found where they are expected. Conversely, it may permit the Proponent to exclude areas from the LSA by saying there are no expected impacts in that area.

2. Various maps depicting the LSA are confusing. Fig. 8-1.1 (original) of Vol. 8 shows a yellow, diagonally hatched area representing the LSA, within which a solid yellow band denotes the *"Probable Extent of year-round Shipping."* The LSA is the area in which the Proponent expects potential impacts to occur (Vol. 2, p. 31). It extends 50 km past the *"Probable Extent of year-round Shipping."* Fig. 8-1.1 clearly indicates that the area of potential impact (LSA) continues south of Nunavut's border and overlaps nearly all of the area of equal use and occupancy, for Nunavut and Nunavik, around Salisbury and Nottingham islands. Fig. 8-2.1 (original) of Vol. 8 shows the LSA as a broad pink area around the nominal shipping route but the LSA illustrated in Fig. 8-2.1 is narrower than the LSA illustrated in Fig. 8-1.1. For example, compare where the east and south boundaries lie with respect to the Spicer Islands, Seahorse Point, Nottingham Island, the Nunavut boundary east of Salisbury Island, and Cape Chidley and compare the east and north boundaries at Bray Island, western Foxe Peninsula, and Resolution Island. The boundary of the LSA is ambiguously illustrated[redacted]. The draft EIS should clearly define whether the LSA is as shown in Fig. 8-1.1 or Fig. 8-2.1. In the absence of a clear answer, we assumed the LSA is as shown in Att_13_Rev. draft EIS

Shipping Figures.pdf Fig. 8-1.1 (Rev.). In our opinion, all calculations that use a different LSA require re-analysis.

3. LSAs were not individually defined for each biophysical component. Such components would logically include life history or population components, such as breeding aggregations, or birthing and nursing areas. For walrus, for example, Table 8.5.5 lists a "*Measurable Parameter*" as "*Change in occupancy of an area that has been identified as important feeding, nursing, breeding* [emphasis added], *or haul-out habitat.*" but the threshold is "*≥10% of walruses in the RSA exhibit strong disturbance and avoidance reactions.*" The proper scale is the LSA related to breeding or nursing, not the whole RSA.

4. By defining the LSA as the extent of possible impacts, the Proponent can not logically end the LSA at a geopolitical boundary. LSAs must include trans-boundary effects. Similarly, the emphasized part of quoted definitions of the RSA in Vol. 8 are in direct contradiction. For example, on page 4 the RSA is defined as "*including potential transboundary effects related to shipping activities*" while on page 8 it states "*The RSA for the southern route includes all of Foxe Basin and Hudson Strait to the Nunavut Settlement Area Boundary.*"

5. The Proponent examined impacts in the RSA in only a qualitative manner (Vol. 2:31), so there are no baseline data by which to measure the whole RSA walrus population (for example); hence the threshold (see previous bullet) is 10% of an unknown number. Qualitative assessment for the RSA is unacceptable because quantitative thresholds are defined on the basis of RSA quantities.

The authors of this Research Document recommend that the Proponent use the source features or biological features that may be impacted to define the geographic scope of the assessment area. Several options are available. The noise from the ore carrier may be detected by walrus 250 km away (Vol. 8:177). This, or a marine mammal with better sound detection capabilities, could be used to define the area within which marine mammals might be impacted. For the marine mammal biophysical component, the LSA would equal the RSA with the addition of Coats and Mansel islands in Hudson Bay. Or the maximal distribution of the potentially impacted organism could be used. Hudson Bay narwhal and beluga, and Foxe Basin bowhead whales, will be impacted as they pass through or reside during winter in Hudson Strait. They could be used to define the area of impact which would include Hudson Bay since consequences of impacts in Hudson Strait may not be seen until the animals have left that area.

Valuable Ecosystem Components (VECs) – Marine Ecosystems

Source(s): Vol. 2; Vol. 8; Responses to IRs

Proponent's Conclusions:

1. VECs would be "*resources that have ecological importance, such as keystone species which, if affected, have a disproportionate effect on their surroundings relative to the types and numbers of other species in a community*" (Vol. 2:34).

2. VECs were "*identified based on either legal or formal recognition of ecological or social importance,*" (Vol. 2:34, Vol. 8:42).

3. "*It is acknowledged that bearded seals are a notable component of the ecosystem and that this species has distinct biological attributes relative to other pinnipeds in the RSA that may make it susceptible to effects from the Project. Nevertheless, Baffinland feels that the marine mammal species selected as Indicators provide a comprehensive and adequate assessment of the Marine Mammal VEC.*" [emphasis added] Preliminary Baffinland

response to IR DFO-03e. *"Bearded seals are common in the LSA and RSA throughout the year (Fig. 8-5.10)… The polynyas of northern Foxe Basin are thought to be an area of high density for bearded seals (Beckett et at. 2008)… IQ notes that bearded seals give birth in April along the southern part of Steensby Inlet."* Extended Baffinland response to IR DFO-03e.

DFO Science Reviewer's Conclusions and Recommendations:

1&2. Despite the draft EIS claim to use the NIRB definition, insufficient and inadequate VECs were selected. There are no fully marine species examined other than mammals. The Arctic Char, chosen to represent the marine ecosystem, is absent from marine waters in winter when most construction and much shipping will occur. No typical food-chain indicators, for char or marine mammals, were examined in any VEC-detail. It appears that indicators were chosen strictly on the basis of their value to local communities. The value of indicators, such as bivalves, to the marine ecosystem *per se* was not considered.

The range of natural variation in VECs was not determined. For example, in Milne Inlet "*Mean taxa richness was higher in 2010 (23) than 2008 (12) (Table 4.3-1)."* (App. 8A-1:49). However, there was no discussion of inter-annual variation or the adequacy of taking only two samples.

3. In its responses to IR DFO-03e the Proponent indicates the abundance and importance of bearded seals in the LSA and RSA but concludes that the marine mammal list of VECs is comprehensive. In our opinion, that conclusion is not supported by the evidence. Bearded seal should be included as a VEC in the EIS.

The Proponent is not in the position to make predictions about impacts on marine forage species (fishes or invertebrates) that are clearly of ecological importance. The limited survey/sampling was confined to the port locations and was not undertaken along the shipping route. The draft EIS contains insufficient baseline data. The Proponent will not be able to monitor changes in lower trophic levels, which have higher turnover rates and are therefore faster to react to potential changes than are marine mammals. Monitoring forage species could serve as early warnings for marine mammal VECs.

We recommend that the Proponent identify additional VECs to fill in obvious gaps in the current list. These should include appropriate food-chain indicators (e.g., *Boreogadus saida*, *Mallotus villosus, Mya truncata*), and the bearded seal. Surveys of marine forage species should be undertaken following acceptable protocols so that detailed quantitative analysis can be used to monitor species and community trends.

Food Chain/Trophic Considerations

Source(s): Vol. 8; App. 8A

Proponent's Conclusions:

Food chain issues are important:

1. *"Water quality is an important component of the aquatic environment as it forms a significant facet of the environment for aquatic life and wildlife. Sediment quality is also important to the health of aquatic biota that live in or on sediments, or that are part of the food chain that includes sediments and/or benthic communities."* (Vol. 8:21)

2. *"Key Issue # 1: Marine Fish Habitat - Physical Habitat alteration (changes due to ore dust deposition, re-suspension of sediments due to prop wash from ships); reduction in*

productivity due to Project-related effects pathways (i.e., lower trophic level effects)". (Vol. 8:95)

3. *"Marine fish habitat was selected as an indicator because it supports marine biota and their food supply. Any Project-related changes to fish habitat have the potential to negatively affect marine biota or their food supply."* (Vol. 8:93)

4. *"There are four primary interactions that represent potential effects on marine mammals from routine Project activities: noise (in-water and in-air), collision with vessels, habitat change, and indirect effects from changes in prey"*. (Vol. 8:141)

5. *"Annual variations in bowhead abundance and distribution are believed to be directly related to food availability (Nunavut Wildlife Management Board 2000)"*. (App. 8A-2:54) and *"... bowhead distribution is likely driven by the distribution of prey species (Thomas, 1999). Bowheads are baleen whales (filter feeders), eating pelagic crustaceans (primarily copepods and euphausiids) and epibenthic invertebrates (Lowry, 1993)..."* (Vol. 8:136)

DFO Science Reviewer's Conclusions and Recommendations:
The authors of this Research Document conclude that the draft EIS is not internally consistent; the treatment of trophic interactions, claimed to be important, is inadequate to properly assess the impact of the Project on this component of the ecosystem.

1. The cited text is the only occurrence of "food chain" in Vol. 8.

2. The cited text is the only occurrence of "trophic" in Vol. 8.

3. The cited text is the only occurrences of "food supply" in Vol. 8.

4. The only occurrences of "indirect" or "indirectly" in the context of food chains are in S. 5.4.4 which says, in its entirety, the following:

   "Marine mammals may be indirectly affected by Project activities because of changes in prey availability and quality. Fish and invertebrates might move to avoid sound sources. Any such distributional shifts would be localized and temporary. Polar bears that forage near the Steensby Port could experience a temporary reduction of ringed seal availability in the area of disturbed landfast ice.

   Given the mitigation measures to be applied, wastes, including contaminants from ore stockpiles, are not likely to affect the prey of marine mammals, hence they would not contribute to the bioaccumulation of contaminants in marine mammals in the RSA." (Vol. 8:147)

   Aside from a statement that says *"About half of footprint of the Steensby Port dock structures is unsuitable as walrus feeding habitat because the only invertebrates present in such shallow water are mobile epibenthos such as amphipods and mysids."* (Vol. 8:176), no discussion is provided of indirect impacts operating through any of the myriad food chains present in the marine environment. "*Mya*" the main food of walrus, is not mentioned at all in Vol. 8 (Marine Environment) or App. 8A-1 (Marine Mammals).

5. Epontic (under-ice) algae and the epontic community which depends on it, are an important component of the Arctic marine ecosystem. Although ice algae are mentioned twice (Vol. 8:6 and 82), "epontic" does not appear in Vol. 8 or appendices App. 3F-1.pdf, App. 8A-1 oceanography.pdf. The draft EIS does not discuss the relationship between the epontic community and pelagic invertebrates (bowhead diet) or benthic invertebrates (walrus diet)

or the direct relationship with ringed seals. Nor does it discuss the impact of ice disruption on the epontic community.

We recommend that the Proponent thoroughly assess impacts of the Project on the food chain within the LSA including along the shipping route. Baseline quantitative surveys should be undertaken before project activities begin, and these should be designed to allow regular monitoring once the project starts.

VECs – Sea Ice

Source(s): Vol. 5; Vol. 8; App. 3F-1 (Enfotec 2010); App. 8A-1, Att_13_Rev. draft EIS Shipping Figures.pdf; 110901-08MN053-Baffinland Response to DFO IR 16-IMCE.pdf

Proponent's Conclusions:
There are adequate baseline data for ice regimes in the RSA to understand the biological importance of ice and responses to climate change.

DFO Science Reviewer's Conclusions and Recommendations:
The authors of this Research Document agree with the following statement made by Enfotec's: *"So, the project will need to ensure decisions taken today consider the long-term affects of possible and or likely changes to the ice conditions along the different routes and port sites."* (Enfotec 2010:41) Regardless, the draft EIS considered neither potential climate changes nor regional differences. There is no discussion of how biota may change, with changing sea ice, in a manner that could invalidate impact predictions. "*Only limited field investigations were conducted to document ice conditions in Milne and Steensby inlets."* (App. 8A-1:17). The phrase "climate change" was never associated with marine ice in Vol. 3 (Project Description), Vol. 8 (Marine Environment), where a discussion about changes in the marine environment might be expected, or App. 8A-1 (Oceanography). Vol. 5 (Atmospheric Environment) included a discussion of climate change but not how the concomitant changes in marine biota would influence predictions about impacts. The phrase "global warming" appeared nowhere in Vol. 3, Vol. 8, or App. 8A-1.

There is no discussion of the ecological role of sea ice and how that might change over the life span of the Project. "Epontic" does not appear in Vol.8 or Enfotec 2010. Enfotec (2010) conducted a detailed ice analysis only in terms of shipping routes and not from an ecological perspective. There is no obvious examination of temporal trends in Enfotec 2010, and the only discussion about climate change is less than a page (page 41) of unsupported opinion. There is no discussion of the pack ice disruption near and around polynyas.

App. 8A-1 did not examine Hudson Strait where shipping through or close to a biologically important polynya is proposed. With no baseline, there was no evaluation of potential impacts in this area.

110901-08MN053-Baffinland Response to DFO IR 16-IMCE.pdf arrived late in the review period. While it purports to address some of the issues raised above, it is seriously flawed and uninformative with respect to these issues. The document may have fallen prey to the contradictory definitions of LSAs (see #1 LSA Scope). On page 3 the document states that *"The proposed shipping route was divided into 22 sections based on latitude and longitude as per the data gathered from the CIS Ice Archive (Environment Canada, 2006) (Fig. 3-1). The area of each section and the proportion represented by a single ship track are presented in Table 3-1.The proportionate area of a single track was calculated in terms of the Local Study Area (LSA) (i.e., the 50 km band along the shipping route). As shown in Table 3-1 a single ship track represents a maximum of 0.2 % of the total area of its respective section."* [emphasis added]

There are two significant flaws in this analysis: the definition of the width of the LSA and the use of a single ship track.

1. Fig. 3-1 shows the "Probable Extent of year-round Shipping" but not the LSA. The LSA is said to be 50 km along the shipping route but it is not said whether this is 50 km on each side of the "Probable Extent of year-round Shipping" as defined in Att_13_Rev. draft EIS Shipping Figures.pdf Fig. 8-1.1 (Rev.), 50 km each side of the nominal route, or 50 km centered on the nominal shipping route. Examination of Fig. 3-1 indicates the 50 km band straddled the nominal shipping route, contrary to the definition of the LSA (Fig. 8-1.1(Rev.)). The more appropriate analysis would use an LSA that extends 50 km past the Probable Extent of Shipping corridor. The incorrect mapping of the LSA renders the calculations in 110901-08MN053-Baffinland Response to DFO IR 16-IMCE.pdf invalid[redacted].

2. It is inappropriate to use a single track because once the pans are broken into smaller-sized pans, they will never reform to being a single large pan, except through consolidation – which creates a different ice habitat. We assume that incoming and outgoing ships will use different tracks. Document 110803-08MN053 BIMC Re Table for DFO IR 20a-IT1E.pdf indicates the metric of ice disruption for fast ice is the proportion disrupted per year. 110803-08MN053 BIMC Re Table for DFO IR 20a-IT1E.pdf did not mention pack ice and 110901-08MN053-Baffinland Response to DFO IR 16-IMCE.pdf analysed only pack ice so readers are left to assume that the standards for ice-habitat disruption are the same for both pack and fast ice.

   There are no data provided to support the assertion that a ship-made lead in pack ice returns to a pre-disruption state (see previous paragraph) over a short time. Experience with *MV Arctic* is cited (Vol. 8:11) but the only datum is a single satellite image (undated, not presented) interpreted to indicate lead closure was within about 1.5 hours. However this is based on an assumed vessel speed roughly three times that indicated for *MV Arctic* in ice 1.5 m thick (http://en.wikipedia.org/wiki/MV_Arctic citing FedNav for 1986 specifications). Without more environmental data relating to this image and without any assessment of the biological implications, assessing the impact of ship-tracks through pack ice is not possible. And if such information is limited or lacking, the authors of this Research Document recommend that directed studies of impacts (such as destruction of suitable breeding habitat for ringed seals, alteration and creation of open-water lead systems, and introduction of new marine mammals species that are able to take advantage of manmade lead systems) early in the project would be useful.

   Analysis of a single ship track as a percentage of the LSA, for which the width needs to be confirmed, is inappropriate thus 110901-08MN053-Baffinland Response to DFO IR 16-IMCE.pdf is invalid.

The authors of this Research Document recommend re-analysis of the sea ice information. It should consider the potential impacts of climate change, and the ecological role of sea ice and how it might change over the life span of the Project. It should also include Hudson Strait in its scope of analysis. The correct size of the LSA should be identified and that, together with a more realistic area of disturbance than a single track width, should be included in the re-analysis. The standards for ice-habitat disruption for pack and fast ice, and evidence that a ship-made lead in pack ice will quickly return to a pre-disruption state, should be provided. The more sensitive landfast ice should be included in the analysis.

Oil Spills

Source(s): Vol. 9 and associated appendices

Proponent's Conclusions:
Oil/fuel spills occur only in the open water season so oil in ice is a non-issue and only within a narrow swath of the proposed shipping lane (in total 30 km wide).

DFO Science Reviewer's Conclusions and Recommendations:
To specifically limit oil spill analysis to summer (open water) months within the proposed shipping lane and define a worse case spill as one that releases 10% of the fuel onboard is inappropriate (details presented in Impacts of Shipping – Oil Spills).

We recommend a more complete oil spill analysis that considers temporal and spatial variation in oceanographic conditions.

Avoidance

Source(s): Vol. 8, Vol. 8 Addendum, Response to IRs.

Proponent's Conclusions:
Arguments detailed in Vol. 8 used the term "avoid" 48 times, almost all (43) of which were in the context of animals moving away from the Project's sources of disturbance.

Baffinland's response to IR DFO-20c states that "*We are unaware of evidence that supports the "ripple effect" theory of disturbance presented by the reviewer. Based on available information, most indicator species assessed in the EIS exhibit temporary and localized avoidance responses to disturbance sources. In situations where there was much uncertainty regarding the nature and duration of an avoidance response, a low or medium level of confidence was assigned and follow-up monitoring was recommended.*"

The Proponent's position is as follows:
1. avoidance nullifies the impact of disturbance;

2. there is no evidence that a displaced marine mammal has only two options – to go where there are conspecifics or where there are not;

3. displacement is temporary; and

4. will be investigated at some point later in the life of the Project.

DFO Science Reviewer's Conclusions and Recommendations:
Avoidance, meaning self-exclusion from an area of disturbance, is displacement and has logical consequences for the animal that the Proponent should have addressed.

IR DFO-20C states that "*The method used to assess the impacts of the Project on marine mammals seems to presuppose that animals are static so only a small proportion in the zone of influence will be disturbed. However, if those animals move away from the disturbance, in most cases they will impact animals in the areas into which they move, causing a "ripple effect". Or affected animals may not have the opportunity to move if nearby habitat is already fully occupied by conspecifics or ice prevents movement.*" It is currently unclear how the effects assessment in the EIS accounts for these scenarios.

In 1985, Kroodsma reported that 79 of 130 EISs he reviewed discussed movement of mobile wildlife out of the disturbed areas, followed by consequences such as increased competition and increased susceptibility to predation. He noted however that only 31 of the 79 "*recognized that the receiving habitats were already occupied by members of the same species*" (p. 83). Obviously, Kroodsma's opinion is that "already occupied" is an acceptable assumption. The two options for displaced marine mammals, even if just displaced temporarily, is to occupy "empty" habitat that was not of the species/individuals' choosing, and likely less suitable than the area vacated, or to occupy habitat already in use by conspecifics and face competition for this space. Walrus, for instance, are socially segregated much of the year (see Born *et al.* 1995 as one example) and this forced mixing can be expected to disrupt that social organization. Mixing large bulls and calves, especially at crowded haulouts often leads to calf mortality (Garlich-Miller 2011). It can be reasonably assumed that increasing the density of marine mammals at favoured foraging aggregations will be detrimental.

Kroodsma concluded that without: "*... evidence showing that:*

1. *Surrounding habitats are suitable.*
2. *Wildlife populations in these habitats are not at carrying capacity.*
3. *Without a project-related influx of dispersing animals, the wildlife populations in the surrounding habitats would not increase the carrying capacity.*
4. *These habitats are capable of supporting the estimated carrying capacity."*...it is not possible to show "*that dispersal minimizes population reduction.*" (p. 86)

Thus it is clear that such an ecological "ripple effect" has been described in the literature for at least 35 years. The draft EIS has not addressed the issue of displaced animals moving into unsuitable or occupied habitat. Consequently, the impact assessment presented is inadequate in this instance. Also, the Proponent's assertion that all displacement is temporary is unsubstantiated. To address such impacts, we recommend the Proponent conduct a thorough analysis of displacement-based impacts and develop appropriate follow-up monitoring.

Thresholds

Source(s): Vol. 2, Vol. 8, IRs; 2. Vol. 8; Vol. 10; App. 10D-10., 3. Vol. 2; Vol. 8; App. 10D-10; SD-EMMP-0010 is the document relevant to shipping and marine mammals. It is not listed in the master Table of Contents but appears to be App. 10D-10.

Proponent's Conclusions:

1. The Proponent stated at the 6 July 2011 meeting in Winnipeg that 10% thresholds are common practice in environmental assessments, and applies it widely in the current draft EIS[8]. For example, the draft EIS states that "*Thresholds are limits of acceptable change determined from regulated guidelines or by professional opinion. ...Wherever possible, quantitative thresholds, determined by relevant regulatory bodies, were adopted for biophysical VCs, however, where these did not exist, qualitative thresholds were considered based on professional judgement.*" (Vol. 2:37)
2. Thresholds are used to predict the level of potential impacts on marine mammals[9].
3. The draft EIS describes thresholds to trigger corrective action[10].

DFO Science Reviewer's Conclusions and Recommendations:

1. The authors of this Research Document could find no reference to a threshold of 10% in Canadian or international EIA guidelines. This threshold is not supported in the draft EIS by discussion of its merit or literature citations.

   DFO Scientists contributing to marine mammal management currently use Potential Biological Removal (PBR) to examine sustainable anthropogenic-induced mortality rates for walrus and some other marine mammal species (see Stewart 2008 and references therein). For walrus, PBR is approximately 1-2% of the minimum population estimate. Currently, the main sources of human-induced mortality of walrus are hunting and climate change (Garlich-Miller et al. 2011). Potential mortality arising from the proposed Project will be cumulative and additional to these sources of removals.

   In the original draft EIS, the Proponent did not specify the timeframe in which the relevant 10% change takes place. 110803-08MN053 BIMC Re Table for DFO IR 20a-IT1E.pdf arrived late in the review process. It is without narrative text but appears to provide time-frames. The objective to disrupt no more than 10% of the area of habitat over the life of the Project may be unnecessarily restrictive in some cases. For example, the table suggests that disrupting 1% of the marine habitat (e.g., pack ice) each year is summed for the life of the project and therefore would exceed the 10% threshold. The timeframe for ice should be "per year".

   Since the threshold for marine mammals other than ringed seals is any mortality in a given year this is, in effect, a temporal scale equal to the life of the Project. The authors of this Research Document wonder what the consequences are for the Project when a single marine mammal, other than ringed seal, is killed.

   As indicated in the Valuable Ecosystems Components (VECS) – Marine Ecosystems section of this document, by the Proponent's standard, the threshold rule (at whatever level is justifiable) must be applied to the segment of the population being impacted.

   As indicated in the Baseline Studies section of this document, the Proponent has provided estimates of neither the size of various components of the population nor the size of the total population for walruses and other species of marine mammals in the RSA.

2. The Proponent's positions in the draft EIS are contradictory; that the threshold is "zero" mortality from collisions, yet at the same time acknowledges that there will be some mortality, albeit low.

   The authors of this Research Document believe that limiting the possible sources of mortality (Vol. 8 Tables 8-5.x) is not justified. Sources of considered mortality should be expanded to include at least oil spills, disruption of the food chain, increased risk of predation, and increased competition (such as for increases in animal density during displacement - see above). Along the shipping route to Steensby Port, *"where vessels are transiting at higher speeds"* (Vol. 8:147) and will not slow down or stop, ship strikes should also be considered a source of marine mammal mortality. This is particularly relevant for ringed seals where *"The risk of vessel collisions… would be highest for seal pups in lairs in landfast ice"* (Vol. 8:146) and bowhead whales as *"baleen whales are likely more susceptible to collision than toothed whales"* (Vol. 8:147).

   In this draft EIS, we are of the opinion that the suggestion that no marine mammal mortality is expected for any species other than ringed seals seems overly stringent and unrealistic. The Proponent should also examine delayed mortality that has been documented to result from episodic disturbances on haulout sites (Fay and Kelly 1980, Cody 2003, Garlich-Miller et al. 2011). Harder to quantify is the effect of chronic disruption (masking/interference) of key mother-young acoustic communications (Charier et al. 2009) and the energetic effects of repeated displacement (see Avoidance section of this document).

It is clear there will, over the life of the Project, be some marine mammals that die as a result of the proposed Project activities. The authors of this Research Document recommend that this be adequately represented in the Final EIS. For example, an analysis of available data from Alaska could provide insights into mortality rates when walrus groups stampede on a haulout. More importantly, sources of mortality other than stampedes, such as underwater blasting and ship-strikes, must be addressed more thoroughly.

As a technical aside, there are no data with which to convert a percentage of the local marine mammal populations into numbers of animals (see Baseline Studies section of this document).

3. In the draft EIS there is no indication what action will be taken when a "corrective action" threshold is exceeded. App. 10D-10 S. 4.5.1 discusses monitoring plans but specifies no options to be considered under "corrective actions"; indeed the only place "corrective" appears states "*establishing corrective measures*" (App. 10D-10:16) without indicating what they might be.

   The scope of the Project is vast. This could exacerbate potential impacts on marine mammals especially because such an operation has not occurred in this area before, a number of potentially-impacted species are being considered for listing under the *Species at Risk Act* (SARA), and baseline data for abundance, distribution and behavioural reactions to disturbing sound levels are limited or do not exist. For these reasons, we recommend that the Proponent outline clearly what types of "corrective measures" will be enacted and for what activities, and what would constitute a successful "correction".

   Currently, there are no data by which to assess trends in marine mammal populations in the study area (see Baseline Studies section in this document) or any food chain indicators which might provide early warning, because none was examined (see Valuable Ecosystem Components (VECS) – Marine Ecosystems section in this document). Further, there is no indication what operational options (if any) exist if the proposed, future examination of the effects of shipping indicates that shipping is disastrous to species such as beluga, narwhal, bowhead whales, walrus and bearded seal in Hudson Strait in winter.

   Overall, as written, the authors of this Research Document conclude that based on this draft EIS there appear to be no consequences, however hypothetical, for exceeding an impact threshold.

We recommend that the Proponent clearly describe the monitoring and mitigation strategies for what we have now concluded could be significant impacts on some of the nearby marine mammal communities.

Residual Effects

Source(s): Vol. 2, S. 3.8.3

Proponent's Conclusions:

The Proponent determined significance of residual environmental effects for the Project using attributes, definitions and rationales provided in Table 2-3.3. Each VEC was considered separately. The overall significance of an effect was based on professional judgment using some general rules of thumb[11].

DFO Science Reviewer's Conclusions and Recommendations:

One of the attributes used is certainty. It is defined as confidence in the knowledge but the example used in the draft EIS is "certainty of occurrence" which is the same as probability ("probability of occurrence"). Certainty is only applied to significant impacts, which not only prevents non-significant effects to accumulate into a significant impact but also contradicts the definition of "certainty". If "level of confidence in the knowledge or analysis that supports the prediction" is low then how can non-significance be stated with confidence?

The levels of duration should not be based on the life of the Project, rather they should be independently determined for each potentially affected organism. For example, medium level (i.e., up to 25 years, for the life of the Project) represents the lifespan of a bearded seal and therefore the current rating system for duration underestimates the significance of Project effects for this species.

For some attributes (e.g., magnitude, extent, reversibility, duration), the determination of non-significance for a single attribute appears to result in non-significance for that environmental effect. In addition, the method used for determining significance of residual effects does not consider impacts on multiple species. During at least the ice-covered season, multiple species may be confined to certain areas and not able to escape Project effects. Impacts to these areas could be significant, from an ecosystem perspective, and are not taken into account using the current method adopted in the draft EIS.

The authors of this Research Document recommend that the proponent employ a holistic approach to the evaluation of residual effects, rather than evaluating each attribute in isolation and basing the overall residual effect on the least significant result. We also recommend assessing residual effects for multiple species by area along the full extent of the shipping route, or at least in and around polynyas especially in Hudson Strait where species at risk aggregate during winter.

EFFECTS OF THE PROJECT ON MARINE FISHES, MARINE MAMMALS AND MARINE HABITAT

Baseline Studies

"*The type and duration of baseline surveys shall be such that there will be adequate information taking account of natural variation to define the existing conditions.*" http://www.epd.gov.hk/eia/english/legis/memorandum/text4.html.

Baseline biological data should describe what species are present, how many individuals are present, and where they are present before the Project starts. Such baseline data serve two important functions, the first of which is to predict potential impacts of the Project. Baseline data on age- and sex-specific components of populations inform the Proponent of the species and habitat that might be affected, where impacts may occur, and the vulnerabilities (age- sex-component affected). The second function is to serve as control data by which to assess the occurrence and extent, if any, of the realized impacts. Variability in baseline data also inform the design of future monitoring programs. The baseline data presented for marine mammals are not sufficiently comprehensive or rigorous to facilitate any of these functions.

Source(s): Vol. 8; App. 8A-2; Att_13_Rev. draft EIS Shipping Figures.pdf

Proponent's Conclusions:
The Proponent's position is as follows:

1. surveys were[12] or were not adjusted[13] for detection and availability biases;

2. they provide sufficient baseline data to predict the proportion of local and total populations exposed to potential impacts;

3. they are sufficient to detect changes in both the components and total population size in time to implement effective mitigation measures; and

4. additional surveys can be conducted, once ecosystem disruption has begun to mitigate Project effects.

DFO Science Reviewer's Conclusions and Recommendations:

1. Vol. 8 and App. 8A-2 contradict each other. Were availability and detection factors used or not? Vol. 8 indicates they were but without sufficient detail.

   Assuming availability is used to mean the walrus are at sea during open-water surveys, it is not clear how the cited papers were used to generate "correction" factors for walrus: *"Correction factors of 2.28, 1.22, and 4.7 were applied to densities for availability bias (Wiig et al., 1993; Jay et al., 2001; Lydersen et al.,2008),"* (Vol. 8:175)

   - Wiig et al. (1993) reported on a single adult male and warned against making generalizations. They do not report on the proportion of time spent ashore versus at sea.
   - Jay et al. (2001) reported that walrus spent 76.6% of their time at sea.
   - Lydersen et al. (2008) reported a 95% CI for the proportion of walruses at sea during the survey between 0.717 and 0.781.

   It is not clear how these citations could be used to generate an adjustment factor of 2.28. In addition, there should be an error term associated with the adjustment factor.

   "detection bias during the ice-covered period (Frost et al., 1988)"

   - Frost et al. (1988) reported on ringed seal basking behaviour and the citation is irrelevant here.

   "and detection bias during the open-water period (assumed the same as for other large pinnipeds; Feldkamp et al., 1989; Stewart and Yochem, 1994), respectively."

   - Stewart and Yochem, (1994) reported on harbour seals, hardly a large pinniped in reference to walrus. They present information on the nature of foraging dives but it is unclear how these data on dive patterns off California are relevant to "detection bias during the open water period" in the Arctic for a larger pinniped with a much different diet.
   - Feldkamp et al. (1989) also report on a smaller pinniped (California sea lion), specifically lactating females which feed at sea then return to nurse their young onshore. The

behaviour of a lactating otariid is completely irrelevant to detecting walrus or any Arctic phocids at sea.

There is some synchrony in walrus behaviour in that they tend to haul out together and go to sea together (see Lydersen et al. 2008) and since the only data the Proponent presents are minimum numbers alive (see below) means are not relevant; maxima should be used for adjusting counts.

2. The marine mammal survey tracks in Hudson Strait skirted Mill, Nottingham and Salisbury islands and did not go into Nunavik waters (App. 8A-2, Fig. A3.2, p. 179), incompletely covering walrus concentration areas. Excluding Nunavik waters makes any assessment of the population size in the RSA impossible. The choice of defining the LSA by expected impacts and designing surveys around this definition is evidently a poor strategy when comparing the irregular boundaries of the ship route and LSA as shown in Att_13_Rev. draft EIS Shipping Figures and App. 8A-2, Fig. A3.2.

   Applicable to all surveys: densities, calculated as the number of animals recorded divided by the area observed (App. 8A-2:85) can not be extrapolated to either LSA or RSA, due to the non-uniform distribution of animals in these two large areas, or to other seasons.

3. The surveys to estimate abundance of marine mammals are inadequate to predict the "numbers of marine mammals exposed" or to allow detection of a population response of about 10%[14] in either the LSA or the RSA.

   Ringed seal surveys
   - The design of the survey lines flown changed between 2006/07 and 2008 in Milne Inlet and in some aspects among all three years in Steensby Inlet (App. 8A-2:81). A systematic survey pattern is needed to provide reliable estimates of changes in distribution and abundance over time in order to assess impacts through the monitoring phase.
   - Survey platform changed in all years, for both sites (App. 8A-2, Table 4.1) making direct comparisons challenging. Using the same methods and aircraft would make year-to-year variation more comparable. Possibly additional problems stem from using a Dornier 228 aircraft (too fast at 315 km/h), a helicopter (too loud and may have reduced density from seals diving before being visually available on transect), and a Twin Otter (low altitude at 91 m and a corresponding small strip width).
   - As a result, results of "before" development are limited in use for comparison with "after" development. Maximum counts can be used as Minimum Number Alive (MNA) but aerial survey estimates can not be used to assess direct mortality (Table 8.5.2). It may be possible to get a population estimate for northeast Foxe Basin/Steensby Inlet provided details of corrections (missed seals, diving seals and seals not on ice) are provided and uncertainty in estimates documented. However, to assess mortality from construction activities and vessel collisions would require a telemetry study of females and newborn pups at the time of birth
   - Seal densities in App. 8A-2, Tables 4.7 and 4.8, appear to be in the order of other ringed seal surveys in Canada documenting that ringed seals prefer high cover, stable and cracking ice habitat (land-fast ice: range 0.21-10.44 seals/km^2, pack ice: range 0.19-1.47 seals/km^2) (Burns and Harbo Jr. 1972, Smith 1973, 1975, Stirling et al. 1977, Breton-Provencher 1979, Finley 1979, Heard and Donaldson 1981, Stirling et al. 1982, Finley et al. 1983, Kingsley 1984, Kingsley et al. 1985, Smith 1987, Kingsley 1990, Born et al. 1998, Simpkins et al. 2003, Frost et al. 2004, Bengtson et al. 2005, Krafft et al. 2006).

Marine mammal surveys

- Survey platform changed in all years in Milne Inlet and from 2006 to 2007/08 in Steensby Inlet (App. 8A-2, Table 4.1) and can not be compared. Maximum counts can be used as MNA but estimates can not be combined.
- Survey altitude changed in all years (App. 8A-2, Table 4.1) and can not be compared. Maximum counts can be used as MNA but estimates can not be combined.
- Foxe Basin surveys were limited to the ship route (App. 8A-2:81) and calculated densities can not be used to estimate abundance in the LSA, let alone the RSA as required.
- Strip-transect surveys for swimming pinnipeds is without precedent and "*High-level aerial surveys can detect only a small fraction of pinnipeds in the water except for the largest species (e.g., walrus) and when large groups of harp seals are present.*" (App. 8A-2, p. 87). Population estimates derived using this method are invalid, although counts can be used for MNA.
- App. 8A-2, S. 4.3.1.1 to 4.3.1.4: There are no population estimates for either the Milne LSA or RSA for narwhal, bowhead, beluga or killer whales.
- App. 8A-2, S. 4.3.2.1 to 4.3.2.5: There are no population estimates for either the Steensby LSA or RSA for narwhal, bowhead, minke, beluga or killer whales.
- The authors are commended for not trying to use open-water surveys to estimate densities of bearded, ringed or harp seals (App. 8A-2:109-110). For exactly the same reason that densities were not calculated for other pinnipeds from open-water surveys they should be ignored for walrus.
- It is not clear how (if at all) haulout counts (if any) were incorporated into density estimates (App. 8A-2:137).
- "*It appears that small numbers of beluga might overwinter in the open-water areas in northern Foxe Basin*. (App. 8A-2:125) but there are no estimates of the size of this group or its age/sex composition, even though the polynya is near the ship track.

4. As part of the Shipping and Marine Wildlife Management Plan, App. 10D-10 lists various data collection proposals as mitigation for Project impacts. Investigating the degree of ecosystem disruption after the Project has started is not mitigation. S. 6, Table 3 (p. 52) lists thresholds and performance indicators, although no thresholds are defined for marine wildlife or for land and resource use. Presumably this table should reflect thresholds identified in Vol. 8, S. 5 of the draft EIS. The mitigation measures identified in S. 8,(p. 55) are very general and should have clearly described what would be done if effect thresholds are exceeded.

Summary

1. There are no population estimates presented for any LSAs or RSAs so the Proponent is unable to predict or assess the proportion of the population impacted.

2. The methods used are insufficient to make such estimates except perhaps for ringed seals.

3. Although there is not a standard survey method adopted internationally for walrus, and this species is notoriously challenging to survey, an open water visual survey is not among methods considered applicable (Garlich-Miller and Jay 2000). "*The main techniques for abundance estimation (relative or absolute) are distance sampling, mark-recapture, migration counts and colony counts*" (Buckland and York 2009) and the standard target is walrus hauled out.

4. When baseline population estimates are available, they must be presented with confidence intervals to be able to assess their power to detect changes (Taylor et al. 2007) (replicates

within a season are useful in reducing Coefficients of Variation). Most marine mammal surveys are too insensitive to detect a decline of 10% per annum although there is more hope for pinnipeds hauled out (Taylor et al. 2007).

5. Alternatively the Proponent could suggest indices to be monitored, with supporting rationale. The surveys conducted to date are inappropriate as such indices.

6. To be able to assess which components are being impacted, and what proportion of the estimated size of that component might be impacted, the Proponent will need to determine the proportional distribution of population components. For example, are all the males in breeding mode in one or two small areas?

The authors of this Research Document strongly recommend that the Proponent design and conduct baseline surveys for marine mammals, including bearded seals, using species-appropriate methods applied consistently, including replicates and estimates of statistical error, prior to undertaking any further Project development. As recommended elsewhere in this document, the list of VECs should include key indicators at lower trophic levels; baseline studies for these should be conducted.

Residual Effects on VECs

The Proponent assumes that there will be tolerance and/or temporary displacement by an (unknown) number of marine mammals as a response to Project interactions (noise, collisions with vessels, habitat change, and indirect effects from changes in prey) and concludes, on this basis, there will be insignificant residual impacts on marine mammals. We will argue in the following sections against this conclusion and that short- and long-term impacts on marine mammals might be non-negligible, especially for species at risk of extinction.

Impacts of Shipping – Vessel Traffic and Icebreaking

Source(s): Vol. 8, S. 5.6 to 5.10, 5.12.2.1, provided in document "110901-08MN053-Baffinland Response to DFO IR 3e-IMCE.pdf" (Bearded Seal)

Proponent's Conclusions:
The Proponent concludes that there would be no significant residual impacts of Project vessel traffic and icebreaking on bowhead, beluga, narwhal, walrus, ringed and bearded seals[15].

DFO Science Reviewer's Conclusions and Recommendations:
The authors of this Research Document conclude that the draft EIS does not contain sufficient baseline sampling and/or other information to support this assertion.

Northern Foxe Basin is a nursery area for bowhead whales. Bowheads in this area may lack sufficient exposure and experience to safely avoid ships. In addition, calves may have limited swimming capabilities and females with calves may be less responsive to vessel traffic. "*Bowhead whales engaged in social interactions or mating may be less responsive than other bowheads (Wartzok et al. 1989).*" (Vol. 8:233). Bowheads use Hudson Strait for both migration and overwintering (Ferguson et al. 2010) and will likely be impacted by the increased and ongoing shipping activity in this area. The impacts of vessel traffic on the bowhead nursery area in northern Foxe Basin and overwintering area in Hudson Strait have not been adequately assessed in the draft EIS.

There are several recurring polynyas and leads that occur in northern Foxe Basin (Barber and Massom 2007). The draft EIS reported that seven narwhal were sighted off the northwest coast of Prince Charles Island in April 2008 suggesting they may have overwintered in northeast Foxe Basin. (App. 8A-2:112, Fig. 4.12) This is supported by recent DFO tagging data and reinforces the need for adequate baseline studies. The draft EIS also reports that "*small numbers of beluga might overwinter in the open-water areas in northern Foxe Basin*" (App. 8A-2:125) Project vessels are expected to take advantage of any available areas of reduced ice[4] such as in and around polynyas. This means beluga, narwhal and other species that make use of these areas will be exposed to vessel traffic on a regular basis. Additionally, the stability and size of polynya boundaries will likely be affected by ongoing ship traffic and icebreaking activities.

Icebreaking along the shipping route may provide killer whales with access to seals and whales wintering in polynyas and leads, especially in Hudson Strait in early spring. There have been reports of killer whales making use of openings in the ice to access prey. In one case, people from Hall Beach and Igloolik report that a pod of killer whales became entrapped in eastern Foxe Basin in winter in the late 1950s. More recently, killer whales were seen in the polynya near the month of Cumberland Sound in April two or three years ago. These reports indicate that killer whales can take advantage of access to wintering areas used by narwhal, beluga, bowheads, and pinnipeds. Access to wintering areas in Hudson Strait in spring is particularly likely and could increase killer whale-related mortality in marine mammal populations that winter there.

The authors of this Research Document conclude that the draft EIS does not adequately assess the impacts of vessel traffic and icebreaking on marine mammals in Hudson Strait and Foxe Basin.

For bearded seals, draft EIS conclusions were based on an audiogram from a species (ringed seal) with different behaviour and vocal properties. Some of the information presented on how bearded seals respond to icebreaking was based on data collected from observers on a vessel following an icebreaker (Jones et al. 2009 as cited in DFO IR3-e, p. 9) and, thus, is not particularly applicable. No information is presented about how bearded seals respond to icebreaking during the spring breeding season (roughly April until early July). During that period, male bearded seals maintain aquatic territories in which they produce vocalizations to advertise their breeding condition. They defend small areas of ocean with elaborate bubble displays, where they vocalize intensively and repeatedly over a period of weeks. Males show strong site fidelity and tenure over multiple years (Van Parijs and Clark 2006). It appears that if a male can successfully maintain/defend his display area for 1-2 years he is likely to do so for a decade or more, which represents most of his sexually active life. Males appear to favour areas with open water and drift ice, and avoid areas of extensive ice cover (Van Parijs et al. 2004), as do females for pupping and nursing (Burns 1981). Yearly fluctuations in ice cover, which could be exacerbated by icebreaking, may alter the long-term mating success of individual males (Van Parijs et al. 2004). Bearded seals are common in the LSA and RSA throughout the year and the polynyas of northern Foxe Basin are thought to be an area of high density. Inuit Qaujimajatuqangit (IQ) knowledge notes that bearded seals give birth in April along the southern part of Steensby Inlet (Baffinland response to DFO IR3-e). It is highly likely that vessel traffic will pass directly through the breeding territories of bearded seals in spring and could affect reproductive success and population stability. Given the discussion in the draft EIS, the impact of vessel traffic and icebreaking on bearded seals during the spring breeding season has not been adequately assessed.

The authors of this Research Document believe that there will be significant residual impacts of Project vessel traffic and icebreaking on bowhead, beluga, narwhal, walrus, ringed and bearded seals. The Proponent should obtain thorough baseline data and use it to re-assess the effects of vessel traffic and icebreaking for all marine mammals taking into account the concerns identified above. The Proponent planned to slow the speed of vessel traffic in Milne Inlet to mitigate the impacts of vessel traffic. The authors of this Research Document recommend the same approach along the Foxe Basin route between the south end of Prince Charles Island and Steensby Port.

The current assessment was based on the eastern route in Foxe Basin (Option B) and is not transferable to the western route (Option A). Should the shallow bathymetry near the mouth of Steensby Inlet warrant a change in the shipping route, a new effects assessment would be needed, particularly as the western route does not have any acoustic barriers (e.g., islands) to reduce sound levels for animals in northwestern Foxe Basin.

Impacts of Shipping – Oil Spills

Source(s): Vol. 9; Vol. 10; App. 9B, 9C, 10D-10

Proponent's Conclusions:
The Proponent's position is as follows:

1. oil contact impacts are dermal, inhaled, ingested or fouled baleen[16];
2. oils spills are highly unlikely because ships in the prescribed route will not have accidents[17];
3. impacts are highly unlikely because only small spills will occur[18];
4. those small spills will only occur in the most favourable (open-water) seasons so the oil will be on the surface only; and
5. be largely confined to a 15 km swath on each side of the proposed shipping lane[19].

DFO Science Reviewer's Conclusions and Recommendations:
The draft EIS is incomplete in considering pathways, simplistic in risk assessment (both occurrence and extent), and very inadequate in spatial and temporal assessment. Vol. 8 on the marine environment should include oil spills.

1. The Proponent identifies four ways oil could impact a marine mammal: dermal contact, inhalation, ingestion and fouling of baleen plates. They do not consider damage to ocular surfaces or interference with olfactory cues (e.g., mother-young bonds) and generally dismiss potential negative impacts[20]. "*There is no irrefutable evidence that links hydrocarbon spills with cetacean mortalities.*" (Vol. 9:88) However, there is also no irrefutable evidence that hydrocarbon spills cause zero mortality. There are no comments on ingestion or inhalation pathways identified by the Proponent.

   For seals, sublethal effects are considered to be insignificant although these can take the form of reproductive failure. The Proponent concludes "*there is little evidence to irrevocably link seal mortalities to oil exposure.*" (Vol. 9:88). This statement indicates there is some evidence that mortalities occur and the Proponent needs to discuss it. There is no discussion of pathways as outlined.

   The draft EIS states "*Similarly* [as with seals], *polar bears can be affected by the consumption of oil-contaminated prey, direct ingestion due to cleaning oil from their fur, or suffer from adverse effect thermal insulation (Dickens et al., 1990).*" but continues without more discussion of polar bears and oil. Polar bears are extremely sensitive to some types of oiling causing mortality (Øritsland et al. 1981, Derocher and Stirling 1991).

2. The Proponent considers the risk of an oil spill occurring to be small because the chances of a ship mishap within the shipping route are small. "*The grounding of the tanker/ship within the shipping route is not deemed a credible scenario, as these ships are equipped with advanced navigation systems including sounding alarms.*" (Vol. 9:81-82). There are two exceptions that should have been considered: a ship can run aground in places where the shipping route is too shallow and when it deviates from the planned route. The bathymetry shows maximum depths of 17 m in parts of the shipping corridor near the mouth of Steensby Inlet while the ship draws 20 m (see details in Shipping Route section of this document). While it is not likely, a ship could run aground in that area. The Proponent fails to acknowledge the risk that ships may deviate outside the prescribed path[21], especially when ships pass in opposite directions, although Vol. 9, App. 9C:15 states that "*one of the principal causes of spills is navigational error where the vessel deviates from it [sic] planned track. This assessment does not considered [sic] the potential deviation of ships from the planned route and such deviations will increase the areas of concern.*"

   The possibility that there may be a mechanical, electronic or human failure at some point in the 4,000 to 5,000 ore carrier passages over the life of the Project is largely underestimated in the draft EIS. The prospect of a ship striking the seabed or another ship needs to be assessed using national or international records on the frequency and severity of such accidents, especially during Arctic winters, and when ore carriers are planning to pass each other on a regular basis in predictable locations. Although in S. 4 of App. 10D-10 it says, "*the planned operation of vessels serving the Project will involve a series of measures designed to detect, reduce or eliminate negative environmental effects, including pollution reduction as well as preparedness capability to address unplanned event*." [emphasis added] (App. 10D-10:28), in general, the draft EIS does not adequately consider unplanned events in its analysis. There is available literature on the frequency of maritime accidents which should be included in the draft EIS.[22] A more quantitative risk assessment is warranted.

3. The analysis of a "worst case" scenario of a fuel spill is inadequate because "worst case" is defined in the draft EIS as a spill of 10% of the cargo or approximately 5 ML. "*For modeling purposes, the total amount of 50 ML spilled is judged to be too large a spill and not a credible amount.* (Vol. 9: 88) "*it was assumed that an amount on the order of 5 ML was a worst case amount worth carrying forward.*" (Vol. 9:89, App. 9B:2, App. 9C:3) in the open water season (App. 9B:1, App. 9C:3). The selected amount of fuel spill and season are not the worst. There is ample evidence readily available that the "worst case" of fuel loss is 100%. For example *Amoco Cadiz* spilled 100% of 68.7 million gallons of oil into the sea and *Merchant* lost her entire cargo of 7.7 million gallons of No. 6 fuel. Other credible but smaller proportions are *Arrow* at 50% of 7 M gallons and *Exxon Valdez* at 20.3% of 53 million gallons. Clearly 10% is an optimistic amount, not a worse case situation.

4&5. The suggestion that diesel oil spills will be short-lived due to the fuels volatility appears to be supported solely by "*Evaporation: the conversion of liquid fuel to gaseous fuel that typically occurs in first five days. In 18 hours, 37% of an instantaneous release of approximately 16,000 L of diesel fuel evaporated under conditions of 10 knot winds and a water temperature of 20°C. This process would be slowed in colder water and accelerated in higher winds.*" (Vol. 9:82). The measured or modeled behaviour of oil on water at 20°C is irrelevant to Arctic conditions; its behaviour on water at -2°C and calm to high winds at -30°C would be more relevant.

   The Proponent considers a collision with an iceberg to be more probable than a seabed or shoreline strike: "*Perhaps more conceivable is a ship collision with an iceberg, ...*" (Vol. 9:82). Nonetheless, and despite apparently dismissing in-port spillage, the Proponent opted to model its selected worse case spill in the ports (Vol. 9:88-89) and not in southeast Foxe Basin or Hudson Strait where encounters with icebergs and other large ships might be more common. Spill trajectories from the sheltered waters of Steensby Inlet were transferred to Hudson Strait. *"Using the results from the more detailed modeling for the Steensby Inlet spill modeling, a 'generic spill' with a 15 km spill radius is assumed for the shipping routes. … The assumed swath width is based on review of the Steensby Inlet probability plots and provides a first order approximation of possible worst-case spill extents, recognizing that tidal currents and wind regimes may differ in other regions"* [emphasis added] (App. 9C:12). Indeed they do: *"During the ice-cover period, winds in northern Foxe Basin and Hudson Strait are predominantly from the west (Hudson Strait only) or northwest"* (App. 8A-1:iv). Fig. 2.2-2 (App. 8A-1) indicates the "northwest" refers to only Steensby.

The tidal currents and wind regimes are different in other regions. It is unrealistic to use currents and winds for an inland sea (Foxe Basin including Steensby Inlet) to make predictions for Hudson Strait or Baffin Bay. Winter conditions need to be assessed for at least three main points along the southern shipping route due to the different features present in northeastern Foxe Basin, southeastern Foxe Basin and Hudson Strait[redacted]. The conditions in these areas vary greatly in time and space and pose extreme conditions for shipping. These conditions (strong and reversing tidal currents, jumbled ice) must be considered when the Proponent examines the fate of an oil spill in winter and the intermixing of oil and ice.

Fig. 8 shows the swath of the modelled spill to include or approach known walrus haulout sites yet App. 9C:30 Fig. 16 shows no walrus wintering areas and App. 9C makes no mention of haulouts or the risk of contamination or the effects on the animals arriving or departing from these areas. As there is a real potential for a spill to occur in winter, the proponent should assess impacts on walrus wintering areas.

Impacts of Shipping – Ballast Water

Source(s): Vol. 8, App. 8B-1, 8B-2

Ballast Water can serve as a vector for the introduction of non-indigenous species and can directly impact marine species and their habitat.

Proponent's Conclusions:

1. Ballast water has potential to introduce deleterious substances and/or invasive species. *"The normal operation of tugs and barges to remove marine equipment and materials during the decommissioning phase is not expected to introduce nutrients, metals, or hydrocarbons to the water or sediments. The possible exception relates to any ballast water exchanges that might occur …"* (Vol. 8:47) But *"adherence to regulations and protocols will reduce the potential for invasive species introductions into Milne and Steensby Inlets."* (Vol. 8:100)

2. Ballast water eddies will form and persist but the extent and duration are as yet unclear[24]. The Proponent says these eddies may cause harm to the benthic environment, but perhaps not much as, *"Benthic biota in Steensby Inlet are exposed to salinity levels within the range of the ballast on an annual basis and it is reasonable to expect that the species present would be able to adjust… There may be some shift in benthic productivity due to ballast introduction but this is expected to be of low to moderate magnitude in the context of overall productivity in the LSA."* (Vol. 8:111-112, see also Table 8-4.8)

DFO Science Reviewer's Conclusions and Recommendations:

1. The draft EIS is deficient in its quantitative assessment of the risk of introducing invasive species. Ballast water exchange is not 100% effective (e.g., Bailey et al. 2011) and given the very high volumes to be discharged over the life of the Project, the authors of this Research Document conclude that there needs to be a risk assessment that considers the primary source ports and the efficacy of ballast water exchange as a cumulative impact.

   The draft EIS doesn't include the anticipated regulatory requirements expected in the near future that would require ballast water treatment. New regulations will require the treatment of ballast water instead of exchange. The draft EIS does not discuss the types or efficacies of treatments the Proponent might be considering, possible residues, if any, and their impacts or the cumulative impact of millions of cubic meters of sterile water being discharged at Steensby Inlet.

2. A large and persistent lens of foreign water will be introduced with potential to impact various food webs by affecting lower trophic levels. Table 8-4.8 notes that there "*may be some reduction in benthic productivity*". These potential impacts have not been discussed, at least in part to the exclusion of phytoplankton, zooplankton and benthos as VECs (see Valuable Ecosystem Components (VECs) – Marine Ecosystems section in this document) and the failure to apply the LSA definition to specific life-history stages (see Scope of Assessment section).

   At Steensby, the discharged ballast water differs from the receiving waters "*During the winter, each ore carrier will discharge approximately 200,000 m^3 of ballast water at the dock side. The ballast will be taken on in the north Atlantic, and will be heated slightly (2-4°C) to prevent freezing while on the vessel.*" (Vol. 8:17) Lesser amounts in summer exceed allowed disruption but the extent and duration of those exceedances are unknown[25].

   In both seasons, ballast water discharge at Steensby port persists in time and oscillates in space, over an area larger than its dimensions. "*... during both the ice-cover and open-water seasons, ballast waters will flow away from shore and pool approximately 600 m offshore in water depths of about 75 m ... During each tidal cycle, this "ballast water eddy" may have excursions of approximately 4 km north and south of the point of discharge.*" (Vol. 8:55) "*...If this analysis is correct, ballast-water eddies will maintain their integrity for considerable time (days to weeks) ... This will be especially true for the larger eddies in winter.*" (App. 8B:13) App. 8B models a single discharge but does not examine how sequential discharges, the second starting about a day after the first ends, add to the lens or eddy of ballast water moving back and forth 4 km. It is not clear whether eddies join or form a closely packed sequence, but presumably the area covered by the bottom-hugging eddy gets progressively larger.

   The fact that the benthos could experience salinities in winter ballast exhanges that are similar to the ones dumped onto them in summer is irrelevant to the life stages and life processes that will experience the summer discharges (see Scope of Assessment section). The potential harm to benthic organisms *in situ*, as eggs or in larval stages has not been considered with respect to the size, persistence and movement of this increasingly large pocket of foreign water. The statement that productivity may be reduced needs to be quantified. This can not happen at the moment because there were no baseline data collected on the population size and distribution of the fauna involved (see Valuable Ecosystem Components (VECs) – Marine Ecosystems section). Similarly the impact on various life stages of potentially impacted species needs to be quantified, but currently can not (see Food Chain/Trophic Considerations section).

Mitigation will be to "*Maximize the volume of ballast discharged prior to arrival dock side*" (Table 8-4.8:103) but "*Ships will retain full complements of ballast during periods of ice cover to facilitate ice breaking and, therefore, the full load of ballast will be discharged at dock side during those periods.*" (Vol. 8:55). Therefore the only proposed mitigation is not applicable to the majority of the shipping.

As the draft EIS is written, there appears to be no room for human failure, and no consideration given if exchange or treatment can not or has not been completed by the time the vessels dock. We recommend that the Proponent develop a contingency plan to address this scenario.

The authors of this Research Document recommend development of a risk assessment that considers the primary source ports and the efficacy of ballast water exchange as a cumulative impact. The final EIS must also evaluate treatment measures that will be used to comply with anticipated regulatory requirements. The final EIS must consider the impacts of ongoing ballast water discharges on lower trophic levels including eggs or larval stages of benthic organisms. Sequential discharges of ballast water should be modelled to better understand the size and movement of the ballast water lens and its potential impacts on the ecosystem. Finally, we recommend development of a contingency plan in the event that ballast water exchange or treatment is not effective.

Impacts of Shipping – Wave Action

Source(s): App. 8a-1

Proponent's Conclusions:

1. Data from one season from a single recorder at one location for no more than two months (App. 8A-1, Table 2.4-1.) adequately describe wave behaviour. "*The* [one] *recovered wave sensor provided data for a location near the proposed ore loading facility (AMEC 2009).*" (App. 8A-1:13) although data from this site reflected locally generated waves only "*During strong wind events, maximum wave heights of 0.9 m with periods of 5.4 seconds were generated, consistent with locally generated waves within the Inlet.*" (App. 8A-1:13). The Proponent speculates: "*Along most of the route to Steensby Inlet, fetch distances are large (10s of kilometres) and maximum wave heights generated by wind events are expected to be well in excess of 1.5 m.*" (Vol. 8:47).

2. Because wave height and period are thought to be within the (unknown) natural range, wave action is not an issue. "*…it is expected that bow wave height will have diminished to well within the wave height observed during natural wind events.* (Vol. 8:47-48); "*Alteration of the ice surface will have negligible effect on the sea ice.*" (Vol. 8:16-17) and "*In most areas of the route, the natural wave regime results in as much, or more, energy reaching the coastline during storm events than from ship-generated waves.*" [emphasis added] (Vol. 8:48)

3. "*… even modest surface disturbance due to wind/waves will cause new ice to break up during the initial freeze period. The bow wave and wake of a ship will have the same effect … ice broken during the initial freezing will have a rougher surface than that which is formed under calm conditions. The spatial extent of this will be highly variable, depending upon the timing and level of disruption by wind, naturally occurring waves, and by ships during the initial freeze period.*" [emphasis added] (Vol. 8:16-17)

DFO Science Reviewer's Conclusions and Recommendations:
The analysis of wave action is based on too few data and makes unreasonable assumptions to arrive at unsupported conclusions.

1. The Proponent has presented virtually no data on wave height or period or the frequency of wave-events for most of the LSA and RSA. The speculation about maximum wave energy is unsubstantiated. There is no consideration of inter-annual variation.

2. Allowing for the speculative conclusion that maximum natural wave height may be 1.5 m, it is an inappropriate standard by which to judge all wave effects. A more relevant analysis would be to characterize the ship wakes at various key sites along probable shipping routes and compare that to the frequency of naturally occurring similar events. For example, a walrus haulout will experience a ship wake every couple of days. How often would it experience similar wave-events without ships? This modelling should also consider the sum of energy on the haulout when two ship wakes coincide and, more importantly, when the ship wake is in harmony with naturally occurring wave-events.

3. Dismissing increases in ice roughness caused by repeated passages of ships on the basis that some roughness occurs naturally is inappropriate. The impact to be measured is that caused by the ship in addition to those resulting from natural sources. The "level of disruption" by the ship will be every other day compared to less frequent naturally-occurring events. IR DFO-15k attempted to address this issue but received no response.

The draft EIS did not consider the effect of more frequent wave-events[1] on walrus haulout behaviour. It is entirely possible that walrus hauling out behaviour is affected by the amount of surf on the beach. Haulouts, at least in the high Arctic, tend to be on sheltered beaches, away from prevailing winds. Ship wakes are not wind-driven and may arrive at the otherwise sheltered aspect of a haulout. Larger and more frequent wave events may alter behaviour and be considered by the walrus as a disturbance. More wave action at freeze-up may also affect the ice-rim on haulouts also interfering with haulout behaviour. This was apparently not considered.

The Proponent identified two notable features of the Steensby Inlet shoreline: "*Two other unusual features were noted in Steensby Inlet: (1) shallow water brine pools, and (2) shallow subtidal patches of white bacterial mat,* Beggiatoa *spp ... Brine pools and* Beggiatoa *patches were essentially 'point features' with limited along-shore extent. Brine pools were always associated with ponded, shallow standing water and very low wave energy conditions. The subtidal* Beggiatoa *patches were also seen in low energy bays, and seemed to be associated with concentrations of decomposing algal drift, which had accumulated in subtidal depressions*" (App. 8A-1:38) There is no information in the draft EIS about the possible impacts of increased wave energy or wave-event frequency on these unusual features. Shoreline erosion resulting from Project activities is not adequately addressed.

The authors of this Research Document recommend the collection of additional baseline oceanographic data throughout the LSA/RSA over a period of two or more years to allow consideration of inter-annual variation. Modelling is needed to determine how often wave events would occur without ships, the sum of energy when two ship wakes coincide and when the ship wake is in harmony with naturally occurring wave-events. Ice roughness caused by repeated passages of ships needs to be considered in the assessment. The impact of wave action on species that inhabit the intertidal or coastal areas should also be evaluated.

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[1] The frequency of wave events is defined here as how often periods of rough water occur while the frequency of waves is the time between two successive waves.

Impacts of Shipping – Sediment Redistribution, Contaminants and Food Chains

Source(s): Vol. 8; 8081SMN-001-MBB-FOXEB1-02-R0.pdf; 8081SMN-001-MBB-FOXEB2-03-R0.pdf; 8081SMN-001-MBB-FOXEB3-04-R0.pdf; 8081SMN-001-MBB-FOXEB4-05-R0.pdf (collectively referred to as BL Bathymetry); Att_13_Rev. draft EIS Shipping Figures.pdf

Proponent's Conclusions:
The draft EIS indicates that both ship passage (Vol. 8, S. 3.5.2.2) and ship discharges (Vol. 8, S. 3.5.2.3), such as ballast water, can re-suspend sediments.

Barge and Ship Traffic (Vol.8:54)

1. Barge, tug and ship traffic can re-suspend marine sediment for distances up to 100 m from the vessel.

2. Ship-generated currents could be between 1.0 and 2.0 m/s (Jay 2002).

3. Sediment disturbance will likely cause increases in TSS, nutrients, and metals in the water column, possibly exceeding water quality thresholds.

4. *"These effects are expected to subside rapidly (hours) after the disturbance ..."*

5. *"The frequency of resuspension events is expected to decline after the seabed environment equilibrates to one with coarser substrates ... after finer particulate materials have been redistributed outside of the disturbance area."*

6. *"Therefore, the magnitude of these effects is expected to be moderate"*

7. Residual impacts from barge and ship traffic on water and sediment quality are both non-significant for both Milne Inlet and Steensby Inlet (S. 3.5.3.2, p. 74).

Discharge of Ballast Water (Vol. 8:55)

8. Ballast water moves about 600 m offshore.

9. Exceeding CCME PMAL water quality limits for salinity is a "moderate" impact.

10. Table 8-3.13 (p. 70-71) indicates that during construction, propeller currents will increase metals concentrations in the water due to sediment disruption and that the mitigative measure is to use approved anti-fouling paint.

11. Sediment relocation is said to be intermittent, of short duration and fully reversible.

12. Sediment relocation will be completed during the construction phase, with no more relocation during operations or decommissioning.

13. Residual impact from ballast water discharge on water and sediment quality will have a non-significant effect for both Milne Inlet and Steensby Inlet (S. 3.5.3.3, p. 74-75).

DFO Science Reviewer's Conclusions and Recommendations:
The draft EIS does not provide sufficient evidence to support its claim, is contradictory in its assessment, and incomplete it its coverage. The presentation includes several errors which force the reader to guess the intent.

1. The draft EIS is ambiguous in saying "*generating currents on the seabed at distances up to 100 m from the vessel.* (Vol. 8:54) in that it is not clear if this is the distance behind the ship or the radius or diameter of the cone of disturbance. Nonetheless the area of impact is likely greater than suggested because the velocities used from the Maury Island Project (Jay 2002) were for tugs and 10,000 ton barges which are considerably smaller than the proposed cape-size ore carriers (160,000 – 190,000 Dead Weight Tonne cargo capacity). Moreover, the propeller design has not been stipulated. For example, while ducted or nozzle-type propellers can produce less underwater noise than open propeller systems (e.g., Greene 1985), they also can output more focused, stronger water plumes.

   The draft of the cape-size ore carriers is about 20 m (Vol. 3 Fig 3-3.9) and, at its most damaging, the 100 m radius suggests sediment redistribution will occur in water to depths of 120 m and possibly more. Water depths are ≤120 m along the probable extent of year round shipping from Steensby port into Hudson Strait (Att_13_Rev. draft EIS Shipping Figures pdf Fig 8 1.1 Rev; BL Bathymetry http://www.whoi.edu/cms/images/Hstrait_bathy_map_60298.png accessed 13 September 2011). Therefore, sediment redistribution would occur throughout this portion of the shipping route and over a wide swath and would represent a large portion of the LSA. Sediment redistribution will also occur in shallow areas of Hudson Strait.

   The final EIS should present a quantitative assessment of sediment disturbance from propeller and thrust wash using velocities and other data applicable to the proposed ship design, over a range of operational modes (open water, light ice, heavy ice, fast ice, etc.)

2. The authors of this Research Document agree that sediment disturbance will likely cause TSS, nutrients and metals re-suspension in the water column. Outridge and Stewart (1999) related increases in metal concentrations in walrus to frequent storm events in Foxe Basin, and the resulting re-suspension of sediment.

3. There are no data provided to support the supposition that sediment re-suspension effects are short-lived (lasting an unspecified number of hours). Clearly this would depend on the particle sizes in question and fine material might remain suspended for a long time.

   There is little in the way of assessing the re-suspension and resettling on biota. The impacts might be very long-lived. For example, re-suspended sediment will be processed by filter feeders which will extract contaminants, such as heavy metals. These metals may show up later in benthic feeding marine mammals. If storms which disturb the sediment result in elevated metal levels in walrus (Outridge and Stewart 1999) there is a real possibility that sediment disturbed by the Project will unnaturally increase the rate at which naturally occurring metals, including lead, enter the fish and marine mammal food chains.

   There was no discussion of the biological impact of re-suspending large amounts of sediments.

4. The frequency of sediment relocation will not decline over time although the volume of redistributed sediment will. Sedimentation is an ongoing process and once the seafloor is initially scoured, new sediment will arrive to be re-suspended on the next ship passage.

5,7&8. It is unclear how exceeding the limits of the LSA in Foxe Basin could be considered "moderate" for propeller wash and ballast water flows, especially because ballast water as a source sediment disruption was not discussed.

6. The claim of non-significance is not supported by the information provided on the area affected and permanency of the impacts of propeller wash.

9. The final EIS for the Maury Island gravel mine included several mitigative measures to reduce the impact of propeller wash (ftp://ftp.kingcounty.gov/ddes/acrobat/mim/feis/content/vol_1/ch_6.pdf, accessed 13 September 2011) none of which appears in the current draft EIS. Anti-fouling paint was not among them.

10.&11. These points are in direct contradiction. We accept that sea bed scouring will be constant, ongoing and long-lasting. The removal of sediment and its deposition to another location are permanent effects. The scoured trough will persist well after the life of the Project and take a long time to return to the pre-disturbance sediment profile. Similarly, the places where the re-suspended sediment lands will have profiles forever altered.

12. The claim that ballast water discharge has no effect on sediment quality is unsubstantiated because there is no discussion of ballast water flows on sediments preceding this conclusion.

This assessment is inadequate in considering the biological effects of re-suspended material on biota, including smothering benthic organisms, blocking light, and increasing the turnover rates of nutrients and metals and their implications up the food chain. The authors of this Research Document recommend a more thorough assessment be undertaken taking into account the concerns identified above.

Impacts of Shipping – Noise

Source(s): Vol. 8, Vol. 8 Addendum, App. 8C.

Proponent's Conclusions:
The Proponent concludes that there will be no significant residual impacts of the Project on marine mammals.

DFO Science Reviewer's Conclusions and Recommendations:
The Project, as proposed using the Steensby Inlet port and southern shipping route, will result in regular shipping and nearly constant marine ensonification of a large portion of Hudson Strait and Foxe Basin (see below). Hudson Strait represents the main wintering area for four populations that the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated as endangered or of special concern, including bowhead whales (Ferguson et al. 2010), Western Hudson Bay beluga (Luque and Ferguson 2010), Northern Hudson Bay narwhal (Vol. 8, S. 5.1.4.2), and Ungava Bay beluga (Finley et al. 1982). Hudson Strait also represents part of the wintering area for the Eastern Hudson Bay beluga population (Lewis et al. 2009) which COSEWIC designated endangered. COSEWIC designated Atlantic walrus, which is found in both Foxe Basin and Hudson Strait, as a species of special concern. If effects of an augmentation of shipping traffic in Foxe Basin and Hudson Strait are non-negligible, it may prevent recovery or contribute to decline in these species.

During most of the year the proposed iron ore carrier navigation paths will coincide with areas of highest concentrations of marine mammals. In addition, as both ore carrier crews and marine mammals will likely seek polynyas and other areas of less ice during ice-covered periods there will likely be an increased risk of acoustic and ship-marine mammal interactions. The Proponent used mean, and not more precautionary maximum, marine mammal densities to assess the proportion of a population likely impacted by shipping activities, and thus likely largely underestimated impacts on species aggregating in areas of lesser ice during ice-covered periods, particularly beluga, narwhal, bowhead and walrus.

The authors of this Research Document recommend that the Proponent re-evaluate their conclusions regarding the portion of marine mammal populations that might be impacted by using more precautionary density estimates, more precautionary conclusions about sound propagation and operational overlaps. A more detailed analysis of this section of the draft EIS follows.

Source(s): Vol. 8, Vol. 8 Addendum, App. 8C., Vol. 8, Table 8-5.9, Vol. 8, Vol. 8, S. 5.12, provided in document "110901-08MN053-Baffinland Response to DFO IR 3e-IMCE.pdf" (Bearded Seal)

Proponent's Conclusions:

1. The Proponent's modelling of acoustic propagation relies on a variety of assumptions regarding ice coverage; the Proponent's conclusions about the unlikelihood of hearing sensitivity and physical damage are based on models of sound propagation and mitigation that relies on behavioural responses of exposed marine mammals. (Vol. 8, Vol. 8 Addendum, App. 8C.)

2. The Proponent used 135 dB re 1 µPa rms as a threshold for avoidance responses in beluga and other marine mammals (Vol. 8, Table 8-5.9).

3. The indicators used to assess the impacts of Project noise are "*changes in occupancy of an area that has been identified as important feeding, nursing, breeding or haul-out habitat*" (Vol. 8:174, Table 8-5.5). The Proponent's position is that animals will avoid noisy areas (> 80 dB), avoidance will be temporary and mere detection of noise does not mean there will be a negative impact[26]. Planned mitigation for vessel traffic noise will be provided by design of the ore-carriers, to reduce noise output, and vessels maintaining a constant course and speed whenever possible (Vol. 8:178).

4. The Proponent used the audiogram for the ringed seal as a proxy for the bearded seal. *"There is no audiogram available for bearded seals so the ringed seal audiogram was used. Bearded and ringed seals produce calls at similar frequencies… so for the purposes of analyses, it was assumed their hearing abilities are similar."* (IR 3e, S. 5.12.1.2)

5. The Proponent recognized that masking of bearded seal and other marine mammal calls may occur but would be short term. *"It is possible than an ore carrier passing through pack ice or the landfast ice edge area in Steensby Inlet during spring and early summer may mask bearded seal calls…. Ore carriers that occur in relative close proximity to bearded seals during the breeding season may mask calls important for breeding. However, any masking that might occur along the shipping route, as a vessel passed by, would occur for a short time (2-3 h) relative to the interval between transits (48 H) on the assumption that eastbound and westbound vessels will maintain a significant lateral separation. The amount of masking will be a function of how close to the ship's path the bearded seals occur."* (IR 3e, S. 5.12.2.3)

DFO Science Reviewer's Conclusions and Recommendations:

1. In the sound modelling described in the draft EIS, there are many modelled sound source levels equal to or greater than accepted TTS thresholds for nearby marine mammals - and many of these sounds will be concentrated in lower frequencies that would be better propagated in many parts of the study area than higher frequencies.

For example, Fig. 7 shows many underwater source levels reaching 200 dB re 1 μPa at 1 m - especially for the *M.V. Umiak II* (which is considerably smaller than the proposed cape-class ore carriers for the Baffinland Project) at low frequencies. All vessels in the modelling exercise are smaller than the proposed ore carriers and this introduces an element of uncertainty in the conclusions. Except at higher frequencies, the source level of the *Umiak* was equal to or higher than transiting vessels. The statement in the draft EIS that "*source levels of land-fast ice breaking at the bow of a large carrier are much lower than the source levels from propeller cavitation.*" does not appear supported in the Figure. The Proponent correctly concludes that the modelled Baffinland ore carrier sound outputs are very high, especially at lower frequencies and while breaking heavy ice. Although we note (below) these sound sources are modelled independently of each other.

The authors of this Research Document wished to know on what grounds the Hudson Strait sound modelling site was chosen (S. 3.1, Table 6). A more open and deeper area to the southeast with greater depths (up to 500 m) might have allowed greater sound propagation (and hence impacts for animals there), and would be the area where an "alternate" east Baffin shipping route might be considered (see below). On the other hand, since the location chosen in the draft EIS has very thick sea ice accumulations perhaps this could still be used as one of the worst-case areas in terms of the energy output needed to move the ships through the ice. On that point we would like to note that in S. 3.2 the 1996-97 modelled sea ice thickness data may no longer apply more than a decade later as 2011 so far has the least sea ice coverage in Arctic history (e.g., http://www.cbc.ca/news/technology/story/2011/09/12/science-arctic-sea-ice-record.html).

The authors of this Research Document recommend that the Proponent conduct further sound modeling in areas with different oceanographic and hydrographic characteristics than just the one site chosen. Further, in S. 3.2.2, and given that the sound speed profiles are modelled based on oceanographic and ice cover historic data, it is highly recommended that field sound measurements be obtained before and after construction and shipping begins.

2. Previous studies have documented "flee" responses, including large herds undertaking long dives close to or beneath the ice edge, break down of pod integrity, and asynchronous diving, for beluga exposed to sounds from icebreakers smaller than those expected to be used in the current Project. These responses were observed while the icebreaker was 35−50 km distant, and when ambient noise levels ranged from 94−105 dB in the 20−1000 Hz band (Finley et al. 1990). These received levels are well below those used by the Proponent as thresholds in this draft EIS. In the case of the beluga study, the whales' return to normal activity was not observed until two to three days after the initial disturbance.

   Such a multi-day recovery latency is equivalent to the time elapsed between two ore carrier passages at the lowest proposed production rate in the current Project. Based on modelling exercises, noise levels in excess of 100 dB in this frequency band (up to 2,000 Hz) will prevail over more than 100 km around an ore carrier when ice is present, and will reach both coasts in the narrowest parts of Hudson Strait (Fig. 8C-A13 to A18). Worse, with this propagation range the acoustic footprints of multiple sailing ore carriers will overlap in many instances (e.g., heavy ice, Hudson Strait), or form a very elongated ellipse through much of the proposed shipping corridor as multiple ore carriers are inbound, loading and outbound.[2]

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[2] We note that sound output from only one ore carrier was modelled at a time, with no consideration for acoustic overlap or adjacency during this rapidly-paced and year-round proposed shipping operation.

At an ice-breaking velocity of approximately 10 km/hr, the 100 km radius noise footprint of a single carrier would take 20 hours to pass a single location; and one carrier following another would have a sound field which would overlap in some locations when the vessels are 20 hours apart. Even carriers operating more than 20 hours apart would not provide a below-ambient noise space along their route for a long duration before the next ship passes. Additionally, when carriers approach one another the overlapping sound fields could result in a received sound level greater than that for a single modelled ship. The shipping noise models were also produced independently of the dredging, blasting, and tugboat operational modelling where - as for the multiple ore carrier scenario - there could be overlap and/or synergy in received sound level exposures for animals near the Steensby port site and Foxe Basin. Finally, there will likely be other shipping and underwater noise sources that occur concurrently with the proposed Project in space and time that would contribute to a cumulative effects situation.

Given these data and reasoning, the authors of this Research Document disagree with the Proponent's conclusion of negligible impacts for beluga. There may be no suitable alternative wintering sites for some of the beluga populations, including the Ungava Bay and Eastern Hudson Bay populations which have been assessed by COSEWIC as endangered. This is also likely true for Western Hudson Bay beluga, and for species such as bowhead whales and narwhal. Even if these whales have no other choice than to habituate to this new, environmental noise source, such long-term exposure could lead potentially to chronic stress (Wright et al. 2011): "*Chronic stress is linked to numerous conditions in humans, including coronary disease and infertility*". Considering the already slow growth rate of these beluga populations, all of which are at risk according to COSEWIC, we can not exclude at this time the possibility of a negative effect that might impair recovery, or reduce growth rates of these populations. Considering that no corrective measure can realistically be implemented in case of significant impacts on beluga or other species once the Project is ongoing (see below), we strongly recommend that alternatives to a southern route and port in Steensby Inlet be reconsidered (see below).

Beluga rely on hearing and sounds to navigate and maintain their social networks. Bowhead whales are also highly vocal (Tervo et al. 2009) and likely mate while on their wintering ground in Hudson Strait. DFO Science disagrees with the Proponent's conclusion that whale reliance on frequencies higher than those where ore carrier noise is concentrated ensures there will be no impact on the mammals' communication (Vol. 8:169, 185, and 205). Although beluga are among the marine mammals having the most acute hearing in terms of directionality and critical ratio, nonetheless beluga in the St. Lawrence Estuary were shown to adjust the frequencies at which they vocalized, repeated their calls, and increased their call duration and amplitude in response to increased background noise from vessels (Lesage et al. 1999; Scheifele et al. 2005). These reactions may be a common strategy in cetaceans to reduce masking as they have been documented in several other species, including killer whales (Foote et al. 2004; Holt et al. 2008), gray whales (Dahlheim et al. 1984), humpback whales (Miller et al. 2000), right whales (Parks et al. 2010), and bottlenose dolphins (Buckstaff 2004; Morisaka et al. 2005) facing high levels of anthropogenic or biological noise. The use of these behavioural strategies may lead to less efficient communication and could increase interpretation errors (Tyack 2008). Given the variability in natural sources of noise, species relying heavily on sounds for communication or echolocation are expected to show a certain degree of adaptation to rapid changes in noise levels (see Tyack, 2008 for a review). Right whales for instance, appeared to change the frequency band they used to communicate as a result of the increase in ocean noise in the Atlantic over the past decades (Parks et al. 2007). Whether acoustic behavioural changes, such as those observed in right whales, may reduce fitness for the whales exposed to the Baffinland shipping operations is difficult to measure. Regardless, it can be surmised that impacts on biological functions are more likely to occur when animals need to rely on these compensatory mechanisms on a regular basis (e.g., Weilgart 2007). This will likely be the case in Hudson Strait and Foxe Basin given the anticipated level of traffic associated with the construction and operation of the Project and foreseeable increase in production or addition of other types of industry on Baffin Island.

The authors of this Research Document recommend that the Proponent undertake modelling of potentially overlapping sound fields from the noisier sound sources, and where there is not overlap in space, make an effort to determine what the temporal lag might be between such overlaps (e.g., for moving sound sources like the ore carriers and tugs).

A recent study of the potential acoustic impacts of loud, localized sound sources in Europe (Booth 2010) employed an integrated sound propagation, hearing model, and distribution approach. While some of the model assumptions are simplistic, with some revision based on the literature, the authors of this Research Document recommend that the Proponent consider such a multivariate approach to modelling the impacts of this proposed operation.

3. Strong disturbance/avoidance in 10% of the population in the RSA is an inappropriate threshold for nursing, breeding, feeding or hauled out animals. Taking walrus as an example, the draft EIS identified trampling as a possible source of mortality (Vol. 8, Table 8-5.5) but did not evaluate potential impacts of noise in terms of trampling. Data should be available from Alaska to assess the risk of death due to stampedes. For no species did the draft EIS examine energetics (including thermoregulation), nursing, feeding or communication, or the components of the population they said would serve as indicators in the tables referenced. Regardless of the threshold used (see Thresholds section in this document), and ignoring the fact that the draft EIS does not provide population estimates for the RSA (see Baseline Studies section), the impacts are on identified groups of animals (e.g., "*Change in occupancy of an area that has been identified as important feeding, nursing, breeding, or haul-out habitat.*" Table 8-5.5), not all animals in the RSA. No walrus feeding areas were identified.

There is no evidence presented in the draft EIS to support the claim of temporary avoidance and there is evidence that was not cited to the contrary (details below). Detection does not necessarily mean disturbance but saying so does not exclude disturbance. Although this statement may apply to other marine mammal VECs and to bearded seals, walrus are generally more sensitive to man-made (and natural) disturbances than other marine mammals[27] and are used here as an example. While there may be physiological similarities, extrapolating behaviour responses from marine mammals in general to walrus is not justified.

The Proponent does not demonstrate that there is no negative impact. The scale of the Project is unprecedented in terms of chronic noise saturation of the marine environment. The noise of ore carriers will impinge on most marine mammals at long distances:

- Ringed seals: at least 250 km (Vol. 8:158)
- Walrus: to 250 km (Vol. 8:177)
- Beluga: more than 250 km (Vol. 8:195)
- Bowhead: more than 250 km (Vol. 8:230)

The diameter of the circle of noise is therefore at least 500 km (radius 250 km).

- Foxe Basin is roughly 250 km across.
- Hudson Strait is less than that except from Baffin Island to the bottom of Ungava Bay (~400 km) although Akpatok Island is less than 250 km from Baffin Island.

- In Hudson Strait, the distance between Salisbury and Resolution islands is estimated at 660 km, just less than noise diameter.

Apparently, while one ship is being loaded, one will be at moorage near the port, one recently departed ship will be somewhere in southeastern Foxe Basin or Hudson Strait, and one approaching the port will be somewhere in Hudson Strait/southeastern Foxe Basin (Bevin LeDrew, pers. comm., 21 July 2011 teleconference). It appears, then, that there will usually be three and sometimes four ore-carriers in Foxe Basin/Hudson Strait at any time. The Proponent needs to clarify the ship densities and identify the places where arriving and departing ore carriers will pass each other. (This information is also required to assess the risk of ship-to-ship collision). This crossing area might be highly predictable and relatively fixed but was not identified in the draft EIS.

Until then, a more simplistic model follows. If the ore carriers will pass any point approximately every 43 h and the service speed is 14 knots (26 kph), although maximum speeds may be 18.5 knots (33.2 kph), then they will be about 1,100 km apart. (They are likely to be closer based on the statement made by LeDrew – see paragraph above). The radius of their detected noise is at least 250 km fore and aft (and to both sides) of the vessel so the gap in noise from any two ships in a line is only about 500 km. When two ships are nearing each other, there will be a period when the combined noise areas stretch 1,000 km, approximately the distance from the port at Steensby to 100 km west of Kimmirut. At 25 kph the noise is 10 h ahead of and behind every carrier so a walrus would hear the ore carriers at least 20 h out of 43 h. Ensonification of the RSA will be virtually complete and constant.

There is neither a discussion of the impact of this chronic noise nor any discussion of sound levels as two ore carriers approach and overlap each other. At their nearest there will be two sound sources in close proximity radiating noise across Foxe Basin and across Hudson Strait.

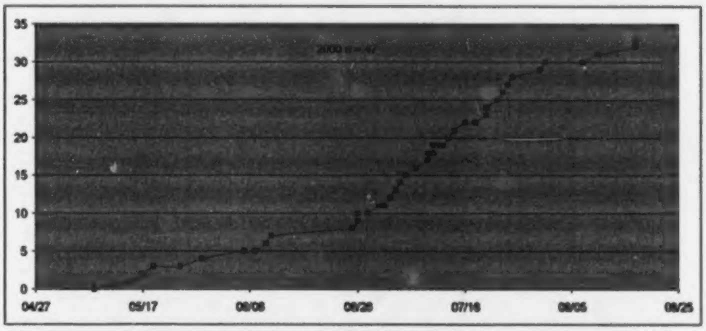
It is therefore entirely possible that any marine mammal in Foxe Basin or Hudson Strait will be aware of the presence of at least one ship virtually its whole life. There may be no time available for a "temporary avoidance" (i.e., quiet time).

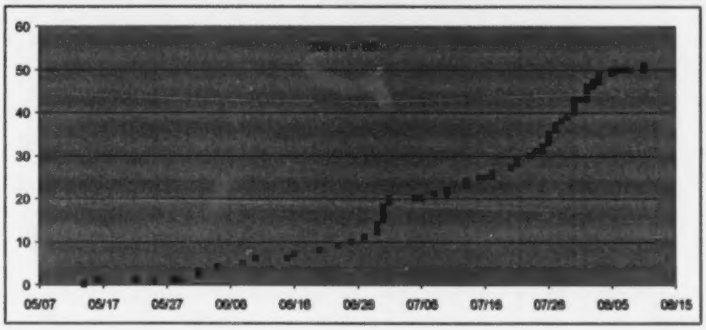
The Proponent suggested that only areas of > 80dB would be avoided temporarily but provided no evidence that areas exposed to chronic and repeated shipping noise < 80 dB will not be avoided as well. Detection of sound does not mean there is necessarily an impact that is observable externally and immediately, but the detection of sound that causes no overt reaction can still result in the distress and displacement of animals over time and this ensonification can not be dismissed as below harmful levels.*"Because some stressful effects depend on qualities of the sound other than its absolute decibel value, the annoyance associated with sound may need to be considered in regard to health effects. .... fear of the noise source and sensitivity to noise both strongly affect the 'annoyance' of a noise."* http://en.wikipedia.org/wiki/Health_effects_from_noise

In consultations, Inuit indicated walrus are frightened by large ships although the response is variable. Speculation that *"marine mammals eventually get used to new sounds and return to areas they may have temporarily left"* may not apply to walrus and is highly qualified: *"however, there is uncertainty about the effects of shipping 12 months of the year (Hall Beach Marine Mammal Workshop)."* Concerns about walrus leaving an area and not returning in response to chronic disturbance are valid[28]. The Proponent's conclusion that "*Based on available evidence, walruses are not expected to leave terrestrial haul-out sites in response to passing ore carriers at these distances." [4.6 km]* (Vol. 8:178) is not supported by the evidence available to DFO and the Proponent, who cite Born et al. (1995)

and COSEWIC (2006) frequently. Instead, the weight of evidence is that walrus have abandoned haulouts that have been chronically disturbed by vessel noise.

The Proponent expressed uncertainty about walrus' ability to habituate to overflights (Vol. 8:182) but did not discuss habituation of walrus to vessel traffic. In the presence of virtually constant noise, habituation is required to permit disturbance to be temporary. There is evidence that walrus at Round Island, Alaska, did not habituate to disruption within a summer season. The draft EIS cites Okonek et al. (2008) which is one in a series of annual Alaska Fish and Game (AFG) reports about wildlife on Round Island between 2000 and 2007[29]. These reports tabulate disturbances and walrus responses. A preliminary examination of the data in these reports indicates that in the seasons for which there were 45 or more potential disturbances there was an absence of habituation in all years with the possible exception of 2001[30] (Fig. 2). There was a strong relationship between the number of departures from the haulout and the number of boat visits, and has been a small but not significant decline in maximum counts at Round Island. Although the proposed number of ship passages for the Mary River Project is vastly greater than at Round Island, these data are germane to assessing the potential for walrus to habituate to repeated disturbance. As described earlier for belugas, there is potential for walrus to experience chronic stress, whether they were to habituate or not, in response to ship noise.





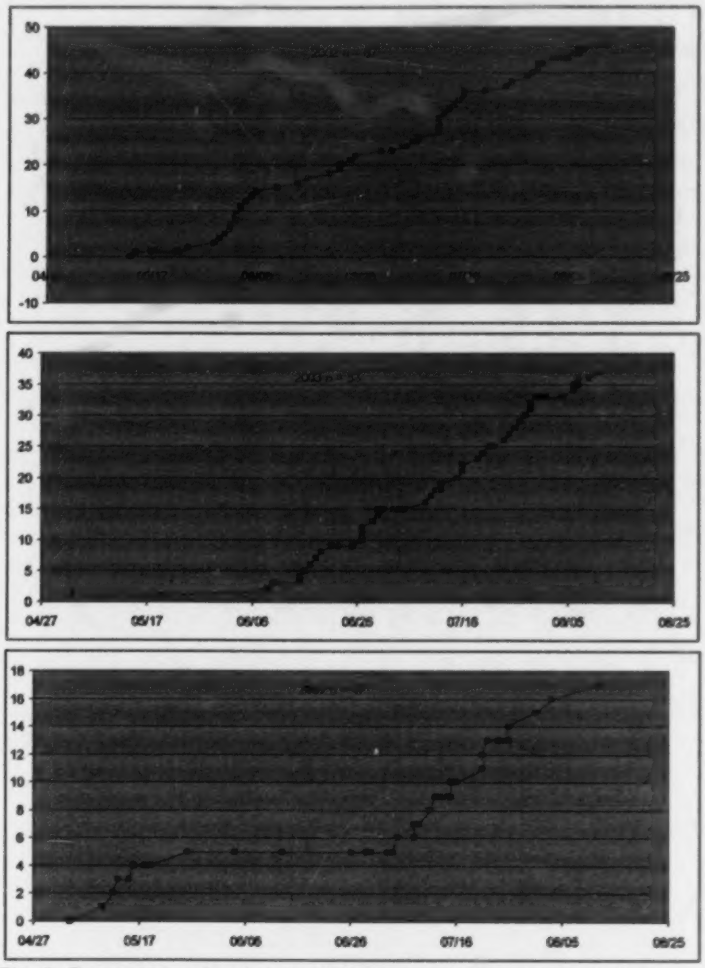


Fig. 2. Responses of walrus to disturbance at Round Island, Alaska, between 2000 and 2008. Date is shown on the x-axis and cumulative responses on the y-axis. Disturbance is scored as 0 or 1 and the results of each potential disturbance are summed each day. If there is habituation, the cumulative curve asymptotes because more zeros will be added later in the season.

Ice-breaking may be particularly disruptive to walrus, not due to the noise of the ice being broken but because of the operation of the vessel[31]. The Proponent agrees "*Walruses hauled out on ice may temporarily avoid an ore carrier transiting to and from Steensby Inlet by diving into the water, perhaps at distances ranging from 400–500 m up to several km.*" but concludes "*Walruses in the calving area are not expected to respond to ore carriers transiting through eastern Foxe Basin either during the ice-covered or open water period*" (Vol. 8:178). They based their conclusion on the only calving area being west of Rowley Island. But Fig. 4.18 in App. 8A-2 shows locations of numerous walruses within approximately 3-20 km of the proposed Steensby Inlet port (numbers of walrus present in a sighting are not indicated).

The draft EIS indicates a variety of distances at which walrus will respond to the noise of an icebreaking vessel: walrus on ice may flee an approaching ice breaker at distances "*up to* *several kilometres*"; that the density of walrus is reduced in areas of ice breaking; and that most groups of walrus reacted at 460 m. The Proponent concluded that the reaction distance is 100 m ("*disturbance onset and avoidance may occur at distances of 1.5 km and 0.1 km, respectively*") (Vol. 8:180). However, this conclusion is not consistent with the evidence.

The draft EIS estimated that <10-400 walrus may exhibit avoidance of an ore carrier passing through the southern LSA during a single vessel passage (Vol. 8:180). DFO Science believes that the data presented do not support this numeric claim. Even if the corrected population densities had merit (see Baseline Studies section in this report) they are irrelevant to ice breaking through the mating, birthing, and nursery areas in Foxe Basin and Hudson Strait.

The nominal and alternate shipping routes both pass directly through walrus calving areas and there is every reason to expect mothers and calves to be disturbed. The impact of ice breaking disturbance, especially in calving areas in eastern Foxe Basin, and in Hudson Strait where the nominal shipping route coincides with the polynya which is home to over-wintering (hence mating and calving) walrus as well as other marine mammals, was not addressed. The level of that disruption and its consequences (communication interference, breaking of the mother-calf bond, malnourished or lost calves) has not been assessed. Walrus need not be displaced to suffer adverse effects.

The draft EIS identifies *"Planned Mitigation for Vessel Traffic - Ore carriers ... design that is expected to reduce noise output....vessels will maintain a constant course and speed whenever possible."* [emphasis added] (Vol. 8:178) thus the planned mitigation measures are unknown and tentative at best and do not meet international measures used elsewhere. For example, Round Island has restricted boat access within 4.8 km (Rice 2000) for far less vessel traffic and shipping only during open water. The noise section of the draft EIS identifies avoidance as a mitigation. The authors of this Research Document, and many published papers, consider avoidance as an impact (i.e., displacement) and therefore it should not be presented as mitigation (see Avoidance section in this document). Mitigation should be activities undertaken by the Proponent to lessen effects of the Project.

4. The available literature clearly reports differences in the frequencies, duration and, especially, the amplitude of calls produced by ringed seals and bearded seals. The assumption that their hearing abilities are similar is not justified by the available information. A more appropriate audiogram should be used for the analysis. (Weddell seal trills are somewhat similar to those of bearded seals and may offer a more suitable substitute than ringed seals. Recent research on trying to develop an audiogram for Weddell seal has been undertaken.)

5. As described previously for walrus, it is likely bearded seals will hear the iron ore carriers for 20 h of every 43 hr period. This would make the Frequency criteria Level III (frequent or continuous) not Level II (intermittent). Note that Table 8-5.22 (Baffinland response to DFO IR 3e) indicates the former level while the text at the top of page 13 indicates the latter. The impact of chronic noise and masking of important bearded seal breeding calls by the ore carriers for the life of the Project is not discussed in the draft EIS. The sound levels as two ore carriers approach and overlap each other is also not mentioned. Bearded seal trill vocalizations can be heard up to a distance of 25 km underwater (Cleator et al. 1989), therefore ship noise has the potential to mask the calls of a significant number of calling seals. The draft EIS says the noise of ore carriers will impinge on most marine mammals at long distances: ringed seals – at least 250 km (Vol. 8:158); walrus – to 250 km (Vol. 8:177); beluga – more than 250 km (Vol. 8:195); and bowhead – more than 250 km (Vol. 8:230).

> Presumably it will be similar for bearded seals so the extent of residual effects on masking by ship noise should be rated as Level II (beyond the LSA and within the RSA) not Level I (within the RSA). The draft EIS indicates the significance of predicted residual effects as not significant but with *"some uncertainty regarding the extent of masking that might occur during winter shipping"*. (IR 3e:15) It is more likely that the magnitude and extent of residual effects from masking is Level II, not Level I. No planned mitigation for masking is provided in the draft EIS. Taking all these considerations into account the authors of this Research Document conclude that the residual environmental effect of masking on bearded seals should have been predicted to be "significant" regardless of whether it is fully reversible at the end of the life of the Project (25 years) which, coincidentally, is the approximate lifespan of a bearded seal.

The authors of this Research Document disagree with the Proponent's conclusion that there will be no significant residual impacts of the Project on marine mammals. We recommend that the Proponent reanalyse the residual impacts analysis for Project effects of shipping noise on marine mammals taking into account the concerns identified above, and propose mitigation measures to reduce masking and noise effects on marine mammals.

Impacts of Aircraft – Noise

Source(s): Vol. 8

Proponent's Conclusions:
Aircraft do not disturb walrus to any appreciable extent and mitigation measures are in place.

DFO Science Reviewer's Conclusions and Recommendations:
The Proponent's position is not supported by the literature cited in Vol. 8.

In general, there has been selective use of source material. For example, Vol. 8:181 says *"Roseneau (1988) noted that low-flying aircraft did not cause disturbance to hauled-out walruses near the Air Force Station at Cape Lisburne, Alaska, suggesting habituation to aircraft noise (Born et al.,1995)."* As written it suggests Born et al. 1995 cited Roseneau and concluded there was habituation. But Born et al. (1995) cited Richardson et al. (1989) for the basis of this speculation. Neither Roseneau (1988) nor Richardson et al. (1989) was available but Johnson et al. (1989) did read Roseneau and collaborated with Richardson and said that in one case a group of walruses was disturbed when a large aircraft took off and flew within a short distance of the resting animals[32]. This part was cited by the draft EIS. But Johnson et al. (1989) thereafter go on to state that Roseneau also notes that some aircraft-related disturbances of walruses have almost certainly occurred over the years[33]. Roseneau's weight of evidence then is that there were several incidents of "flushing" and only one when flushing was expected but not present. It is possible that the single incident was noted because it was unusual but should not be presented in the draft EIS as evidence that overflights usually do not elicit a response in walrus.

Given that Roseneau wrote those words in 1988 and the USAF base had been closed since November 1983, the time-frame of these observations is unclear and the long-term effect, if any, not addressed.

Vol. 8:181 states habituation to aircraft might occur and that responses at Round Island were variable, citing Okonek et al. (2008).The series that includes Okonek et al. 2008 are annual Alaska Fish and Game (AFG) reports from Round Island[29] wherein "merely raising their heads" is the first level of measured disturbance. It occurred for two jet-liner over-flights in 2008 so Okonek et al. (2008) is irrelevant to suggest that habituation might occur. Moreover, if one examines more of these reports, one sees that the number of aircraft passages that were known to cause some reaction (head raises to leaving the haulout) (Table 1). These few data suggest there was no habituation and there remains a high frequency of disturbance to overflights. These disturbances can be severe: "*it has been reported that walruses have stampeded from Round Island in the Walrus Islands State Game Sanctuary as a result of airliners flying overhead at approximately 30,000' (Okonek 2009, pers. comm.).*" (Garlich-Miller et al. 2011)

It must be noted that the number of flights recorded (40) at Round Island over 10 years averaged about one flight per month. The USAF flights at Cape Lisburne averaged about one flight per month (Malme et al. 1989 Table 5.1). Also, "*walruses are particularly sensitive to changes in engine noise and are more likely to stampede when aircraft turn or bank overhead.*" (Garlich-Miller et al. 2011:70). Thus daily disturbance by jets (Vol. 8:181) approaching and departing the port at Steensby, with the attendant changes in direction, speed and altitude, is highly likely.

Table 1. Walrus reactions to aircraft overflights at Round Island, Alaska, (2000-2003, 2005-2010).

Year	Number of times disturbed/number of overflights observed [number of additional overflights with no observations]	% of overflights that were seen to cause disturbance
2000	4/6 [4]	67%
2001	1/2	50%
2002	8/8 [2]	100%
2003	2/2 [1]	100%
2005	1/1 [1]	100%
2006	[1]	
2007	1/2	50%
2008	2/2 [1]	100% (one at an estimated altitude of 30,000 ft and one at 3 miles)
2009	no flights	
2010	3/6 [1]	50%

The draft EIS says "*Planned Mitigation for Aircraft - Except during takeoff and landing, Project aircraft will be operated at a minimum altitude of 450 m over marine areas, when weather conditions allow*" (Vol. 8:181). Excluding takeoff and landings eliminates the most disruptive phases of flight and, while there is no justification for 450 m, there are examples of larger separation distances. Malme et al. (1989) estimated a slant zone of 1.1 km (B737) and 1.2 km (B727) for 100 dB for Pacific walrus. Garlich-Miller et al. (2011:57) recommend minimum slant distance for small fixed wing aircraft of no less than 860 m and 2,066 m for helicopters, citing (http://alaska.fws.gov/fisheries/mmm/walrus/pdf/review_2011.pdf). At Round Island, airplane access is strongly discouraged within three miles and 5,000 vertical feet (1,524 m) of the island (Rice 2000) for a slant distance of 5.1 km. "*To reduce disturbance, overflights of most walrus haul-out sites in Russia are prohibited within 50 km except by special permit (U.S. Fish and Wildlife Service 1993).* " (Born et al. 1995:75)

The authors of this Research Document recommend a more thorough assessment of aircraft noise impacts on marine mammals, in particular walrus. We also recommend the use of more stringent measures for mitigation at Steensby Port.

CUMULATIVE EFFECTS ASSESSMENT (CEA)

Source(s): Vol. 9, S. 1.0.

Proponent's Conclusions:

1. *"The assessment of a single project determines if that project is incrementally responsible for adversely affecting a VC beyond an acceptable level. The CEA must make clear to what degree the project under review is alone contributing to that total effect."* [emphasis added] (Vol. 9:1)

2. *"Interactions are only considered if their assessment would influence the decision regarding approval by the regulatory reviewers."* (Vol. 9:1)

3. *"On a VC specific basis, the zone of influence (ZOI) of residual Project effects was compared with the ZOI of other projects and activities. Cumulative effects were identified where an overlapping interaction in time and space was determined."* (Vol. 9:3)

4. Assumptions were used to determine spatial boundaries for each VC including *"conservative assumptions about the magnitude and probability of the effect."* (Vol. 9:4)

5. *"There is no systematic inventory of historical accidents and malfunctions from other projects that could interact with the Mary River Project, and consequently it is not possible to quantitatively assess the potential contribution of cumulative effects from other project accidents and malfunctions."* (Vol. 9:6)

6. *"...while the proponent can manage effects of the Project, management of cumulative effects requires a coordinated, multi-stakeholder approach that focuses on management specific effects on specific resources. In the absence of adequate data and jurisdiction for determining and managing cumulative effects, the best response to cumulative effects is adaptive management using coordinated information sharing and feedback loops to reduce risk and increase the success of management actions. Baffinland has agreed to contributing data, where reasonable or possible, to the Nunavut General Monitoring Program with the objective of contribution to the knowledge base of changes to the long-term state and health of Nunavut." ..."Baffinland is committed to contribute to the NGMP by sharing data used in the preparation of the EIS."* (Vol. 9:7)

7. *"The monitoring program has been designed to be as non-intrusive as possible. For example... bird and marine mammal aerial surveys will be carried out early during the Project life and will be either discontinued or reduced frequency as the Project life advances."* (Vol. 9:10)

8. S. 1.3.2.9, Shipping lanes with the potential to interact with the Project does not mention Davis Strait. (Vol. 9:17-18)

9. S. 1.4.4.1, Sea ice: The second paragraph assesses the impact of ice breaking on disruption of fast ice, and thus ringed seal habitat, in Steensby Inlet. It also examines how that might change with a doubling of production due to expansion of the Mary River Project to mine other deposits. The calculations were based on a *"conservative estimate of the size of ship track"* and that the estimate of disruption of fast ice is *"conservative"*. (Vol. 9:37)

10. The draft EIS states that with a doubling of production due to expansion the threshold for protection of ringed seal habitat (i.e., 10%) would be reached in June and exceeded in July. It also says that it is *"possible but less desirable operationally"* to reduce the area

disturbance. Regardless, the conclusion reached is that the Baffinland would commit to reducing the overall footprint of ice breaking in the fast ice to *"within acceptable levels"* if an increased production scenario is undertaken. (Vol. 9:37)

11. S. 1.4.4.2, Marine water and sediment quality: "*Alternate forms of ballast management may be considered if effects are determined to be unacceptable.*" (Vol. 9: 38)

12. S. 1.4.4.3, Marine habitat and biota: *"No cumulative effects to marine coastal habitat are expected… it is expected that a doubling in the frequency of which ore carriers discharge ballast water at each of the ports will not adversely affect water quality; therefore, an increase in effects to arctic char health are not expected."* (Vol. 9: 39)

13. *"It is expected that adherence to legal requirements regarding ballast water exchange (or alternatively, treatment) will be effective mitigation in addressing this potential concern [invasive species introduction], and that an increase in shipping as a result of the Project will not change this conclusion."* (Vol. 9: 39)

14. S. 1.4.4.4, Marine mammals: *"Residual effects are predicted for the marine mammal VEC (all six indicator species). Project effects, with the exception of potential masking for bowhead whales, are not predicted to occur outside of the LSAs."* (Vol. 9:39)

15. *"Although cumulative effects have been identified as a possibility for several VCs, particularly caribou and marine mammals, no significant cumulative effects are anticipated to result from the Project."* (Vol. 9:48)

DFO Science Reviewer's Conclusions and Recommendations:
In our opinion, the draft EIS does not adequately describe the methods used to conduct the CEA. The analysis is based on some questionable assumptions, is qualitative only in most places, and arrives at unsupported conclusions.

1. To accurately reflect the true impacts of the Project, the CEA must take into account the residual effects from the Project together with all other non-Project threats also operating within the Project area. For example, if the Project was to cause a 1% increase in annual mortality of ringed seals within Steensby Inlet above the natural level, while hunting and climate change each produced an additional 10% mortality, ringed seals in the area would experience a significant cumulative impact. Yet the Mary River Project *alone* represents only a 1% increase, which would be considered insignificant because it did not meet or surpass the established >1% threshold. However, if current level of mortality is close to what the species can sustain, even a small increase such as 5% could have a significant impact. Thus it's important to fully assess the combined effect of the Project with all anthropogenic, but non-Project, threats already extant in the area. This also means that non-significant impacts need to be included as they may, cumulatively, constitute a significant effect. The Proponent needs to consider the interaction of single effects within the Project as well. For example, what is the total impact on a species which receives (perhaps non-significant) impacts from habitat destruction (say ice), noise and reduced prey availability?

2. All interactions should be analyzed and presented so that regulators can assess the full cumulative effects of the Project and decide which ones are significant.

3. Environmental effects resulting from a Project can extend beyond the immediate temporal exposure and spatial range of the Project, and can accumulate over time and space. The criteria used to determine overlapping interaction in time and space should be defined.

4. Assumptions about magnitude and probability of effect should be based on at least moderate, not conservative, expectations. The term "conservative" is not defined here but is understood to mean near the low end of the spectrum ("avoiding excess" according to one dictionary definition). The methods used to determine magnitude and probability of effect should be described fully.

5. A systematic inventory of historical events should be obtained because it could provide a quantitative assessment of the likelihood of similar accidents and malfunctions occurring with the Mary River Project and permit a CEA of the Project and other projects within the ZOI.

6. Given that Baffinland plans to rely on this approach to *"reduce risk and increase the success of management actions"* it is imperative they make their data public so that others can monitor and review Baffinland's efforts to conduct a thorough CEA and provide appropriate follow-up and response as the Project moves forward. The Proponent should also contribute data obtained during the Construction, Operation, and Closure phases of the Project in keeping with the multi-stakeholder approach they mentioned.

7. The Proponent must explain when in the life of the Project the aerial surveys will be reduced or discontinued, and explain how it will be possible to effectively monitor, manage and mitigate effects throughout the life of the Project if bird and marine mammal aerial surveys will be infrequent or not conducted at all. The Proponent should also explain how relatively infrequent survey flights at a constant velocity and altitude are more disturbing than frequent 737 flights, and include both in the CEA if indeed survey flights are so disruptive.

8. Shipping lanes in Davis Strait should be included in this section.

9. Worst case estimates should be used to incorporate some degree of caution into the analysis to account for unknowns or mistakes in assumptions and calculations. Quantitative assessments that include a probability of occurrence and the degree of consequence should be used.

10. Based on the results of their analysis and operational concerns, the Proponent should have concluded that a doubling of production is not appropriate in terms of the impact of ice breaking on disruption of fast ice, and thus ringed seal habitat, in Steensby Inlet.

11. The draft EIS must explain what ballast water effects would be considered *"unacceptable"* and, in that case, what *"alternate forms of ballast management"* may be undertaken.

12. It is not possible to conclude that no cumulative effects to marine coast habitat are expected without developing baseline information about, and subsequently monitoring, the biological community near and more distant from the discharge site. The chosen VECs do not include any primary or secondary producers or year-round residents of the nearshore fish community. Monitoring key species in the lower trophic levels would permit the effects of ballast water to be detected more directly and readily, and mitigation measures to be undertaken more swiftly. The draft EIS only considers a seasonal visitor, Arctic Char, and concludes everything will be fine.

13. It is commonly known that no one ballast water treatment method is 100% effective. *"Because no one method has yet been proven to remove all organisms from ballast water, more research must be conducted into improving existing treatment methods, developing*

new methods, and determining the effectiveness of combining ballast water treatment methods." (quote obtained from Marine Bioinvasions Fact Sheet: Ballast Water Treatment Options, available online at http://massbay.mit.edu/resources/pdf/ ballast-treat.pdf.

14. Residual effects are predicted for all six marine mammal VECs yet the draft EIS provides no CEA for marine mammals or discussion of how the residual effects may be influenced by a doubling of the Project. This oversight should be corrected.

15. The draft EIS provides no evidence to support the conclusions that no significant cumulative effects are anticipated to result from the Project.

The CEA considers the impacts of a doubling in production. While this approach is not appropriate elsewhere in the draft EIS, it is appropriate for the CEA. Regardless, none of the technical comments provided by the authors of this Research Document for the CEA should be construed as support for a doubling of production.

GENERAL CONCLUSIONS

The draft EIS represents a massive volume of work but is highly repetitive, difficult to read and suffers from ambiguous organization[34]. This makes it difficult to find relevant information when reviewing the draft EIS. Many key components of the ecosystem get limited or no consideration in the report. There are no credible marine organisms other than marine mammals included as Valuable Ecosystem Components (VECs), which means there is no discussion of indirect or trophic effects. There is no discussion of fuel spills in ice. There is no discussion of sub-lethal effects or delayed mortality.

The draft EIS selectively presents information. This selectivity includes ignoring advice within its cited expert reports. The draft EIS relies on many reports, prepared by subcontractors, which are often very good, as far as they go. But the draft EIS frequently ignores cautionary notes in these appendices. For example, while Enfotec (2010) strongly recommended the Proponent consider the long-term ramifications of climate change on ice regimes, there was no evidence found that the draft EIS did so. In another example, Furgo (2009) noted that underwater shoals in the area pose a hazard to navigation near Koch and Rowley islands and Enfotec (2010) noted that ice on this route may necessitate more maneuvering by the ships. These factors argue against the eastern Foxe Basin route but no discussion of this was found in the draft EIS; nor was there discussion about alternate routes. Similarly, in its response to IR DFO 16, the report states that ice-breaking will have a greater impact on fast ice than on pack ice – but the report deals only with the less impacted pack ice (page 1).

The draft EIS also suffers from ambiguous use of key terms. For example, the Proponent often uses the term "conservative" but in many cases it is not clear what is meant. "*The lower the certainty of occurrence, the more conservative the approach to the prediction of significance.*" (Vol. 2: 41, Table 2-3.3) Does this mean that if the Proponent is uncertain if some effect will happen (low probability), the draft EIS would be more or less likely to declare significance? The reviewers recommend that Baffinland make clear its use of the term "conservative" and would, ideally, remove it entirely and replace it with terms such as "risk averse", "least likely", and "most (or least) far-reaching".

There are a number of errors in the draft EIS. For example, a citation is given to support a claim that aircraft overflights do not disturb walrus (details presented in Impacts of Aircraft Noise section of this document) but failed to acknowledge the rest of the paragraph being cited that would lead to the conclusion that the absence of walrus response was, in fact, unusual. In another case, Vol. 3 takes excerpts from Enfotec (2010) and credits them with a citation to

Knight Piesold (2008), which they did not make. Frequently details presented in the draft EIS are confusing and/or inconsistent. Discussion of sea ice thickness[35] and boundaries of the local study area (LSA)[36] are good examples of this.

The reviewers conclude that the draft EIS is unrealistically optimistic in a number of its conclusions with regards to potential impacts. For example, App. 9C (Spill Sensitivity of Proposed Port and Shipping Routes) purports to discuss the worst case scenario for an oil spill. The expert report however was constrained to a spill of not more than 10% of the fuel onboard in the open-water season, and is based on data from Steensby Inlet. It is clear from the draft EIS that Hudson Strait is more likely to be the site of a ship collision (icebergs) and more shipping is proposed for the ice-covered season than the open-water season. There is no information on the fate of a diesel fuel spill that is (a) large, (b) in ice, or (c) large and in ice. The worst case oil spill scenario presented is a partial fuel cargo loss in summer which is a more optimistic scenario than during the winter when ships sometimes break up completely. A more realistic worst-case scenario would be a large spill in winter when cleanup would be difficult and environmental impacts greatest. The over-optimistic approach also makes no allowance for human, electronic or mechanical error, or just bad luck; potentially catastrophic events are dismissed out of hand[37].

There was no quantitative cumulative effects analysis presented in the draft EIS. Determination of overall significance of a residual environmental effect resulting from the Project was based on evaluation of a number of attributes and employing professional judgment. The qualitative analysis appears to be based on the assumption that if two or more impacts are each non-significant (NS) then when they are combined they remain non-significant. The Proponent used 10% as an impact threshold, the value of which was not based on a cited source or precedent. With the approach adopted in the draft EIS, a NS designation for multiple impacts could result in a qualitative assessment of NS+NS+NS = NS whereas a quantitative calculation might be 9%+9%+9% =27%. If this was the case, the overall cumulative effect would, in fact, be significant. The analysis is also based on some general rules of thumb[11]. Non-significance for a single attribute (e.g., reversibility) could result in an overall evaluation of "not significant".

With the current state of knowledge about marine mammal behavioural and physiological responses to sounds from anthropogenic activities such as those proposed in the Baffinland draft EIS, the authors of this Research Document conclude that an alternative eastern Baffin port location may result in fewer impacts on marine mammals, and based on this, appears to represent a better option for current and future development of industrial activities on Baffin Island. An eastern Baffin port site may be less invasive environmentally and offers marine mammals the shortest exposure to the negative effects of large-scale shipping.

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APPENDIX 1. Endnotes

Alternate Port Criteria

1. For example, from Rev. Vol. 3:123-124:
    - Technical Feasibility (TF): "2 *...technically effective and reliable with contingencies ...*"; but "*1 ...appears effective based on modelling / theoretical results and contingencies are available...*"
    - Cost Implication: "2 *is the preferred alternative ...most favourable return on investment for the investor*" but "*1 represents an acceptable alternative*"
    - Valued Socio-Economic Components (VSECs)/Community Acceptability: "*2 represents the option that is deemed to be the "preferred" option by ...multiple stakeholders*" but "*1 represents an option which is also acceptable to the stakeholders.*"

2. For example:
    - "*Mitigation Measures - Management actions or strategies applied to minimize or eliminate negative environmental effects. They are also used to reduce or eliminate the potential residual effects of the Project and are identified in each of the effects assessments, along with potential residual effects of the Project*". (Rev. Vol. 3:158)
    - "*Some measures such as using an owner familiar with navigation in sea ice and experienced Ice Navigators would provide mitigation.*" (Rev. Vol. 3:103)
    - "*Potential mitigation measures relating to shipping interactions with marine mammals is provided in the Shipping and Marine Mammal Management Plan (App. 10D-10).*" (Rev. Vol. 3:121)

Shipping Route

3. "*The bathymetric surveys were carried out for the Project to meet CHS standards.... The preferred route and the navigational charts have been studied by experienced ship masters at Fednav who have practical knowledge of ice interpretation and navigation in ice conditions.*" (Vol. 3:109)

4. The draft EIS indicates that ships are not expected to adhere to the illustrated routes [emphasis added]:
    - "*Mitigation measures include icebreaking vessels limiting the width of the shipping lane to <1.5 km by sailing along the same track as much as possible through landfast ice in Steensby Inlet.*" (Vol. 8:243)
    - "*... ships will pass to the south of Mill Island (between Mill Island and Salisbury Island) to the extent possible ... ships will likely need to pass to the north of Mill Island... when ice conditions are very poor, to maintain safe and reliable passage*" (Vol. 3:155)
    - "*... during operation, the ships Master may chose to vary the route from the identified corridor as required to ensure the safety of the crew, the vessel and its cargo.*" (Baffinland response to IR DFO-15A)
    - "*The shipping route is defined; however it is not fixed, and shall be flexible in response to safety and weather factors.*" (Baffinland response to IR DFO-15d)
    - "*A depth of 25 m has been identified as a minimum acceptable water depth for the shipping route. ... but Fugro (2009) indicated that careful consideration must be given when finalizing the route in central Steensby Inlet and along the east side of Steensby Inlet, as numerous shoals occur in those areas. Fugro (2009) further indicated that the surveyed area near Koch and Rowley (see Fig. 2.1-3) may present some navigational challenges related to corridor width.*" App. 8A-1:6

Scope

5. For example:
    - *"Local study area (LSA) - Area where there exists reasonable potential for direct interaction due to project activities, ongoing normal activities, or to possible abnormal operating conditions (i.e., accidents and malfunctions). Individual LSAs were defined for each biophysical environmental component, and for land use and other socio-economic components [emphasis added]."*
    - *"Regional study area (RSA) - Area within which there exists the potential for direct, indirect, and/or cumulative biophysical and socio-economic effects. ...Confidence and accuracy of predicted effects was generally reduced at this scale, with qualitative analysis more common than quantitative analysis [emphasis added]."* Vol. 8:4
    - *"The LSA was defined as "that area where there exists the reasonable potential for immediate impacts due to project activities, ongoing normal activities, or to possible abnormal operating conditions", including Project facilities and the full extent of the proposed shipping route within the Nunavut Settlement Area. The RSA was defined as "the area within which there exists the potential for direct, indirect, and/or cumulative biophysical and socio-economic effects including potential transboundary effects related to shipping activities."*

Local Study Area

6. For example:
    - Vol. 8: 8 *"The LSA for the sea ice assessment refers to the area that includes the shipping corridor and a 50 km wide zone on either side of it. ...The RSA for the southern route includes all of Foxe Basin and Hudson Strait to the Nunavut Settlement Area Boundary. The LSA is illustrated in Fig. 8-2.1."*
    - 110704-08MN053-08-Vol8 Addendum-IDTE.pdf says: *"Fig. 8-1.1 Marine Study Area (No Change)"* (Page 1) and 2 *"Fig. 8-2.1 Shipping Route to Steensby Inlet (No Change)"* (Page 2). However Att_13_Rev. draft EIS Shipping Figures.pdf contains only 2 figures: 8-1.1 (Rev.) and 8-2.1 (Rev.). 110704-08MN053-08-Vol8 Addendum-IDTE.pdf is wrong.
    - Att_13_Rev. draft EIS Shipping Figures.pdf, Fig. 8-1.1 (Rev.) adds a 15 km setback for Resolution Island; otherwise there were no detectable changes relevant to LSA and the probable shipping path compared to Fig. 8-1.1 (original).
    - Fig. 8-2.1 (Rev.) is vastly different than the original. The pink/orange LSA band is much narrower than illustrated in Fig. 8-1.1 (original or revised) or Fig. 8-2.1 (original). Now the LSA = the "Probable Extent of year-round Shipping" and excludes Mills Island as well as areas of equal and shared use and stops at the Nunavut boundary. It says, in effect that the Proponent expects *"that area where there exists the reasonable potential for immediate impacts due to project activities, ongoing normal activities, or to possible abnormal operating conditions"* ends abruptly at the Nunavut border and surrounds but does not impact areas of walrus concentration. Jurisdictional issues aside, this renders all calculations of the size of the LSA and all comparisons of impact relative to that size, invalid.
    - Is the LSA in Rev. Fig 8-2.1 erroneously labeled? Since 110704-08MN053-01-Vol3 Addendum-IDTE rev v 3.pdf Fig. 3-1.1 illustrates the same area as the "Probable Extent of year-round Shipping" the LSA in Fig. 8-2.1 (Rev.) appears to actually be the area of shipping. In that case, is the LSA as indicated in Fig. 8-1.1 (Rev.) or Fig. 8-2.1 (original)?
    - Vol. 9, Fig. 9-1.2 labels the same yellow stripe as the *"Maximum extent of year-round project shipping."* This too is erroneous because in many places the Proponent indicated the ships will travel where the Master thinks they should so the maximum extent has not been stated.

Response to DFO IR 16

7. For example:
    - Working from a printed copy of the map and measuring along the nominal shipping route, S. S-10 (Fig 3-1) appears shorter (~50 km) than S-9 (~65 km) but Table 3-1 says the LSA segments are 3500 and 2500 km^2 respectively. The areas reported in Table 3-1 are contradictory to the areas illustrated in Fig. 3-1 so the conclusions about the percentage of the LSA disrupted by a single vessel track can not be assessed.
    - For segments in Fig. 3-1 to approximate 2500 km^2 and extend 50 km each side of the nominal track (total 100 km) they should be about 25 km long, when clearly they are longer than that, which means the width used was less than 50 km. Indeed segments that are ~50 km long and only can approximate 2500 km^2 if the width is 50 km.
    - The proper analysis would use an LSA that extends 50 km past the Probable Extent of Shipping corridor and be in the order of 165 km wide for S-10, of which 65 km is the probable extent of year-round shipping. The incorrect mapping of the LSA renders the calculations in 110901-08MN053-Baffinland Response to DFO IR 16-IMCE.pdf invalid.

Thresholds

8. Vol. 8 applies 10% to a great many ecosystem components including the following:
    - Table 8-2.2 page 13 Disruption of landfast ice within Steensby Inlet should be less than 10% of the surface area.
    - Table 8-4.7 Criteria for determining effects on marine fish habitat: <10% is low impact.
    - Table 8-5.1
        - o *"Decrease of 10% or greater in suitable ringed seal pupping habitat at Steensby Inlet"* and
        - o *"≥10% of ringed seals in the RSA exhibit strong avoidance reactions …"* and
        - o *"… >10% of ringed seals in the LSA are exposed to sound levels (pulsed) …>10% of ringed seals in the LSA are exposed to sound levels (continuous) …"* but
        - o *">1% of population in Steensby Inlet (including pups)"*
    - Similarly in Tables 8-5.5, 8-5.9, 8-5.12, and 8-5.15 for walrus, beluga, narwhal, and bowhead, except that for these mammals no mortality is allowed.

9. For example:
    - Vol. 8, Tables 8-5.1, 8-5.5, 8-5.9, 8-5.12, and 8-5.15 allow for 10% of the populations to be disturbed, 1% of the RSA ringed seal population to be killed, and no mortality permissible for walrus, beluga, narwhal, and bowhead from stampedes (walrus) or ship collisions (all).
    - Vol. 10, Table 10-7.2 indicators are marine mammal mortalities and observable changes in behavioural or geographic distribution of marine mammals; thresholds are significant changes in behavioural patterns of marine mammals along the shipping route.
    - App. 10D-10:
        - o Page 31 *"the risk of collisions with adult seals, walruses, whales and especially polar bears was considered to be very low. … mortality from vessel collision would not significantly affect marine mammal populations."*
        - o Page 37 *"The objectives of mitigation measures for aircraft overflights are primarily to reduce disturbance effects on marine mammals and in the case of walrus potential mortality from stampeding."*

10. For example, in Vol. 2:49:
    - *"Each EMMP: specifies criteria or thresholds to trigger corrective action based on its monitoring results;"*
    - *"Trends are monitored and exceedances of pre-established thresholds are reported along with justification for corrective action"*.

In Vol. 8:201:

- *"There is much uncertainty associated with the estimates (see S. 5.5.5 for details), including the avoidance threshold level, density estimates and their correction factors, and how overwintering belugas that are potentially foraging will respond to icebreaking vessels compared to belugas migrating to summering habitat. There is also much uncertainty about the duration of the effect… Using the indicator and threshold criteria provided in Table 8.5-9 as a guide, monitoring and follow-up are required to examine the effects of shipping on belugas in Hudson Strait during the ice-covered season (see S. 5.8.5)."*

Qualitative Assessment

11. Rules of thumb (Vol. 2:48) for significance of impacts are as follows:
    - If the magnitude of the effect is low, then the predicted effect is "not significant," recognizing that magnitude includes consideration of sensitive species, habitats, or populations. If effects on measurable components such as air or water quality meet applicable performance criteria, standards, or guidelines, then the magnitude of the effect is negligible to moderate, and therefore the prediction will be for an effect that is "not significant."
    - If the geographic extent of the effect is confined to the potential development areas or LSA, then the predicted effect is likely to be "not significant."
    - If the extent of a negative socio-economic effect is limited to individuals who also receive a corresponding positive benefit, then the predicted effect is likely to be "not significant."
    - If the effect has a moderate to high reversibility, the predicted effect is likely to be "not significant."
    - If the duration of the effect is short-term (e.g., construction period only) then the effect prediction is also likely to be "not significant."

Survey "Correction"

12. "*Densities derived from aerial survey data collected as part of the baseline data collection program for the Project were corrected for detection and availability biases, then used with the calculated areas to estimate the expected numbers of marine mammals exposed to a given sound level.*" (Vol. 8:149) [emphasis added]

13. "*Density estimates were not corrected for detection or availability biases.*" (App. 8A-2:85) [emphasis added]

10% Impact

14. Tables 8-5.x Measurable Parameters and Threshold Values for [insert species e.g., ringed seals (Table 8-5.2, p. 154)] Thresholds are 10% of ringed seals in RSA, 10% of ringed seals in LSA and 1% of ringed seal population in Steensby Inlet.

Residual Effects – Marine Mammals

15. For example:
    - Vessel traffic: *"Few authors have described the responses of pinnipeds to boats, particularly large ore carriers, and most of the available information concerns pinnipeds hauled out on land or ice. During the open-water season in the Beaufort Sea, bearded (and ringed) seals are commonly observed close to vessels….in places where boat traffic heavy, there have been cases where seals have habituated to vessel disturbance." "Based on acoustic modelling and an assessment of [ringed seal] audiogram and ambient noise data, it is predicted that bearded seals in the water would avoid ore carriers travelling during the open-water period along the Steensby shipping route by*

<100 m… bearded seals hauled out on ice may temporarily avoid an ore carrier (i.e., be diving into the water)…perhaps at distances up to 500 m." (IR 3e, S. 5.12.2.1)

- Residual effects of vessel traffic: *"Bearded seals avoidance to a passing ore carrier during the open-water period is expected to be localized and short-term."*
- Residual effects of icebreaking: *"It is likely that at least some of the same bearded seals, particularly those located at the landfast ice edge of Steensby Inlet, will be affected multiple times by icebreaking during the course of a single ice-covered season. Based on available evidence, disturbance effects on bearded seals are expected to be localized and temporary."* (IR 3e:8-10)

Oil Spills

16. "*Spilled oil may affect marine mammals through dermal contact, inhalation, ingestion and/or fouling of baleen plates in the case of mysticetes (e.g., bowhead whales). The potential for marine mammals encountering a hydrocarbon spill will be short-lived due to the high volatility and relatively small volume of the spilled fuel (diesel or kerosene) and confinement to surface water. No significant negative residual effects are anticipated for marine mammals as a result of small volume accidental spills."* (App. 10D-10:31)

17. "*During consultations for the Project, one of the key concerns was the potential effects of shipping on marine mammals. …. An accidental release of fuel from a vessel could also affect marine mammals but preventative measures and contingency planning substantially reduce the risk of such an event (see Vol. 9).*" [emphasis added] App. 10D-10:30

    "*The grounding of the tanker/ship within the shipping route is not deemed a credible scenario, as these ships are equipped with advanced navigation systems including sounding alarms.*" (Vol. 9:81-82)

    "*… protocols are well established for commercial shipping in the Arctic… a number of small fishing and harvesting vessels … commercial ships communication protocols and surveillance systems are well established to maintain communication with other vessels and avoid collision. For smaller vessels, the size of the ore carrier and their observation system should be adequate to warn smaller craft of their presence. In addition, the Company will notify local communities when ships are expected to be in the area. There is a possible likelihood of collision with other vessels but with a predicted very low risk."* (Vol. 9:80-81)

18. "*While the potential for large marine diesel spill is considered unlikely, a spill is possible and worst-case spill scenarios are developed for both the port areas and for the shipping routes.*" (App. 9C:7)

19. One of the assumptions for this assessment is that spills are likely to originate along the proposed shipping routes. However, one of the principal causes of spills is navigational error where the vessel deviates from it planned track. This assessment has not considered the potential deviation of ships from the planned route, and that deviations will increase the areas of concern.

20. Published studies on oil spill impact on marine mammals cited by the Proponent: "*Whales are generally not at great risk to hydrocarbon fuel spills because they rely on a layer of blubber for insulation, and oiling of the skin does not appear to have adverse thermoregulatory effects (Kooyman et al., 1976; 1977; Geraci, 1990; St. Aubin, 1990). There is a possibility that the baleen of bowhead whales could be contaminated, thereby reducing filtration efficiency, though these effects are expected to be minimal and reversible (Geraci, 1990).*

Shipping Route

21. Neither Transport Canada nor any other agency enforces adherence to any particular route, aside from Traffic Separation Schemes (TSS) "*I have confirmed with our Navigation Safety and Radio Communications section that there are NO REGULATIONS under TC Marine Safety that regulate marine traffic routing. Vessels in a traffic separation scheme (colregs) may be an exception, however there are no TSS in Foxe Basin.*" (email from David Avey (TC) to Jaideep Johnar (TC), July 26, 2011).

Accidents

22. Maritime accident statistics:
   - About 75-96% of marine casualties are caused, at least in part, by some form of human error. "*...human error contributes to:*
     - *84-88% of tanker accidents*
     - *79% of towing vessel groundings*
     - *89-96% of collisions*
     - *75% of collisions and*
     - *75% of fires and explosions*"

   (http://www.geovs.com/_UPLOADED/Human%20Error%20and%20Marine%20Safety.pdf)
   - Maritime accident rate was in 2007 was about 5/billion tonne-km (http://www.gateway-corridor.com/torontoworkshop/documents/presentations/Lawson_John_Toronto.pdf) At 21 Mt/yr (Vol. 3:1) and a within-Canada shipping distance of ~1500 km, the proposal is for 31.5 billion tonne-km each year for 20 years.

   - Electronic navigational systems are not fool-proof, Colwill, R.D & Wong, C.H. "Marine Risk Assessment and its Role in Port Management", Asia-Pacific Conference on Risk Management and Safety. 2005 cited in http://www.myprojectspace.eu/AppDocuments/tblDocuments/140/D2.3.2.1%20Review%20of%20collision%20and%20grounding%20risk%20analysis%20VTT%2003June09.pdf found "*In the "VTS-based AIS study", 94 vessels were investigated and in 18% of the vessels there were incorrect ship beam value, in 47% incorrect ship length value, in 30% incorrect navigational status and in 74% incorrect vessel type information entered in the installation of the AIS equipment.*" Of course AIS (Automated Identification System) coverage in the Arctic may be incomplete.

Hudson Strait Oil Spill Model

23. There is evidence that tidal currents and wind regimes in Foxe Basin and Hudson Strait are extreme and vary temporally and spatially. Excerpts from http://www.ccg-gcc.gc.ca/e0010736 (accessed 22 July 2011):
   - "*Hudson Bay, James Bay, Hudson Strait, and Foxe Basin ...region ... is characterized by shallow water depths except ...Hudson Strait is a deep channel ...which, in combination with its southeast/northwest orientation, serves to focus the tidal effect ...producing the largest tidal ranges in the world.*"
   - "*... for Ungava Bay and Hudson Strait ... tidal effects can reverse the near surface current by 180° ...cause the ice cover to be very rough, and often under pressure. ...vast areas of rubble in Hudson Strait, and tide induced pressure can cause ships to become beset in the ice for periods of up to several hours.*"
   - "*...winter ice cover in this region is composed of many different thicknesses of ice that are all very rough. Continual ice motion allows rafting, ridging, and hummocking to take place throughout the winter.*"
   - "*The predominant northwest wind causes the ice to be pressed tightly along the ... southeastern shore of Foxe Basin. Tide-induced pressure also occurs in Foxe Basin. ...*

causes the ice cover in eastern Hudson Strait to become very compact when the tide is rising."

- *"Extremes occur in Foxe Basin where areas in the southeast can have ridge frequencies of 24 ridges per km, average ridge heights of 1.3 to 2.0 m, and maximum ridge heights of 5.0 m."*
- *"Extreme ice conditions in this region are notable."*

Ballast Water Eddies

24. For example:

- At Steensby Inlet "*Ballast water modelling (described in App. 8A-1) indicates that during both the ice-cover and open-water seasons, ballast waters will flow away from shore and pool approximately 600 m offshore in water depths of about 75 m… move in an oscillating semi-diurnal northerly and southerly motion with a gradual net northward drift. During each tidal cycle, this "ballast water eddy" may have excursions of approximately 4 km north and south of the point of discharge.*" (Vol. 8:55)
- *"During the open-water season, the average salinity of the Inlet at the depth of ballast discharge is* [21%] *lower … than the salinity of the Labrador Sea and… ballast water in Steensby Inlet may result in a change in salinity greater than the water quality threshold (i.e., <10 % fluctuation relative to background). However, the change in salinity in the open-water period would result in conditions that currently occur in Steensby Inlet in winter"*. [emphasis added] V8:55
- *"Over the summer and winter discharge periods, … ballast water will experience four ebb-flood directional changes and reach alongshore excursions of around 4 km to the north and south … We speculate that pooling of the ballast water will occur … and that this pooling effect will lead to the formation of a near-bottom, clockwise rotating "ballastwater eddy". … eddies will retain a degree of spatial integrity …Confirmation of these empirical results and speculation for the formation of a ballastwater eddy requires further analysis …."* (App. 8B-1:14)

Ballast Water Exceedances

25. Lesser amounts of ballast water in summer exceed allowable disruption: "*a change in salinity greater than the water quality threshold (i.e., <10 % fluctuation relative to background).*" (Vol. 8:55) and "*Consequently, ballast during summer months … resulting in water quality guideline exceedances for salinity change … The spatial extent over which exceedances will occur will be dependent upon the volume of ballast discharged and on mixing rates … but the rate of mixing between ballast and the receiving waters could not be determined. Consequently, it is difficult to speculate upon the spatial extent over which local waters would remain above guidelines.*" (Vol. 8:111-112)

Shipping Noise

26. For example:

- *"As noted earlier, for purposes of analyses, walruses are assumed to avoid areas where the sensation level is above 80 dB in the 1/3-octave band with the highest sound level (see Davis and Malme, 1997). Some walruses are assumed to exhibit minor behavioural responses at a 70-dB sensation level. Avoidance would be temporary."* (Vol. 8:176)
- "*walruses may detect Project activity sounds at ranges of 10 km (drilling through ice) to 250 km (ore carriers). However, the mere detection of the presence of a distant sound source will not negatively affect a walrus (see Richardson et al., 1995a).*" (Vol. 8:177)

Walrus Sensitivity

27. For example:

- *"Their [walrus] apparent sensitivity to intrusive sounds is considerably greater than harbor seals."* (Malme et al. 1989:6-7).

- *“The reactions of the walruses also depend on age and sex, group size and behaviour (e.g. Salter 1978, 1979, Fay 1981, Orr et al.1986).”* (Born *et al.* 1995:74)
- *“Potential negative effects of noise on walruses include: 1) trampling of calves during stampedes, 2) insufficient rest, increased stress and energy expenditure, 3) insufficient suckling of calves, 4) interference with feeding, 5) masking of communication and 6) impaired thermoregulation in calves that spend too much time in water.”* (Born et al. 1995:74)
- *“Potential effects of prolonged or repeated disturbances include displacement of animals from preferred feeding areas, increased stress levels, increased energy expenditure, masking of communication, and the impairment of thermoregulation of neonates that are forced to spend too much time in the water (USFWS 2008: Chukchi Sea ITR EA: http://alaska.fws.gov/fisheries/mmm/itr.htm).”* (Garlich-Miller *et al.* 2011:69)

28. For example:
    - *“Hunting and noise disturbance caused by motorized transportation have caused herds to abandon uglit near communities in favour of less accessible islands and shores (Born et al. 1995). Whether these animals would eventually habituate to disturbance and reoccupy abandoned uglit if hunting ceased is unknown.”* (COSEWIC 2006)
    - *“Prolonged or repeated disturbances may cause walruses to abandon uglit”* (Salter 1979a in COSEWIC 2006).
    - Settlement, boat traffic and hunting were offered as causes for long-term abandonment of areas by walrus in western Foxe Basin by Crowe (1969), Beaubier (1970), and Brody (1976), all cited in Born *et al.* (1995).
    - *“Intensive year-round ship traffic, including the use of large ice breakers in winter, reportedly has had a negative impact on walruses in the western Russian Arctic, particularly in the southern Barents Sea (Timoshenko 1984). In recent years, hunters from several villages along the northwest coast of Alaska have commented to the United States Fish and Wildlife Service that the abundance of walruses in the retreating spring pack ice declined at about the time when large ocean-going tugs arrived in the area, pulling barges of supplies destined for more northerly villages and industrial sites (U.S. Fish and Wildlife Service 1993).”* (Born *et al.* 1995: 75)

29. Series of annual Alaska Fish and Game reports, in addition to Rice (2000), about wildlife on Round Island:

Rice, S. 2001. Walrus Islands State Game Sanctuary Annual Report 2001. http://www.arlis.org/docs/vol1/WalrusIslands/709805293-2001.pdf

Rice, S. 2002. Walrus Islands State Game Sanctuary Annual Report 2002. http://www.arlis.org/docs/vol1/WalrusIslands/709805293-2002.pdf

Cody, M. 2003. Round Island field report May 3 - August 10, 2003. http://www.arlis.org/docs/vol1/RoundIsland/714160020-2003.pdf

Okonek, D.C.and M. Snively. 2005. Walrus Island state game sanctuary report 2005. http://www.adfg.alaska.gov/static/lands/protectedareas/walrusislands/pdfs/rireport.pdf

Okonek, D.C. and M. Snively 2006. Walrus Island state game sanctuary report 2006. http://www.adfg.alaska.gov/static/lands/protectedareas/walrusislands/pdfs/ri_06report.pdf

Okonek, D.C., B. Okonek, and M. Snively. 2007. Walrus Island state game sanctuary report 2007. https://secure.wildlife.alaska.gov/refuge/pdfs/ri_07report.pdf

Okonek, D.C., B. Okonek, and M. Snively 2008. Walrus Island state game sanctuary report 2008. http://www.adfg.alaska.gov/static/lands/protectedareas/walrusislands/pdfs/ri_08report.pdf

Okonek, D.C., S.K. Sell, and E.W. Weiss. 2009 Walrus Island state game sanctuary annual management report 2009. https://secure.wildlife.alaska.gov/refuge/pdfs/ri_09report.pdf

Sell, S.K. and E.W. Weiss. 2010 Walrus Island state game sanctuary annual management report 2010. http://www.adfg.alaska.gov/static/lands/protectedareas/walrusislands/pdfs/ri_10report.pdf

30. It may be possible to use Round Island (2000-2010) walrus data to examine decadal trends. Initial statistical analysis of these reports suggested the following:
    - the number of events (natural, air and water disturbances) may have declined a bit over time but Adjusted R-squares are low;
    - the absolute number of responses declined with a modest adjusted R-square but this can not be separated from the apparent decline in events;
    - the response rates (responses/event and responses/boat visit) both declined marginally (0.03 and 0.04 per year) but had normality and co-variance issues; and
    - there were solid positive relationships between the number of responses and both the number of events and the number of boats.

Ice-Breaking Noise

31. Ice-breaking may be particularly disruptive to walrus: *"The reaction of walruses to vessel traffic appears to be dependent upon vessel type, distance, speed, and previous exposure to disturbances. Underwater noise from vessel traffic could "mask" ordinary communication between individuals. Ice management operations are expected to have the greatest potential for disturbances since these operations typically require the vessel to accelerate, reverse direction, and turn rapidly thereby maximizing propeller cavitations and resulting noise levels. Previous monitoring efforts suggest that icebreaking activities can displace some walrus groups up to several kilometers away; however most groups of hauled out walruses showed little reaction beyond 800 m (0.5 mi) (Brueggeman et al. 1990). Environmental variables such as wind speed and direction are also thought to contribute to variability in detection and response (USFWS, Chukchi Sea ITR EA: http://alaska.fws.gov/fisheries/mmm/itr.htm)."* (Garlich-Miller et al. 2011:70)

Aircraft Noise – Selective Citation

32. "*Similarly, Roseneau (1988) reported that walruses hauled out along rocky beaches near the Air Force Station at Cape Lisburne often ignored low-flying aircraft. In one case* [emphasis added], *a group of about 50 sleeping walruses were not disturbed (did not respond) when a 4-engine Hercules C-130 cargo aircraft took off from the Air Force station and flew within 0.8 km of the resting animals. According to Roseneau (1988), "Noise from the climbing, departing aircraft flushed many seabirds, but the walruses did not respond to the disturbance."*

33. "*Roseneau also notes that "Some aircraft-related disturbances of walruses have almost certainly occurred at Cape Lisburne over the years, Site personnel have related several incidents* [emphasis added]..*of groups flushing from landing aircraft when animals have been hauled out near the western end of the runway.. . . However, the arrival of varying numbers of summering and migrating walruses remains an annual event."*

Organization

34. For example, trying to find information about large volume oil spills and marine mammals led to the following search:
    - Vol. 8:141 directs the reader to Vol. 9
    - Vol. 8:205,221,239 directs the reader to App. 10D-10
    - App. 10D-10:31 directs the reader to Vol. 9

- Vol. 9:78-81 lists "*potential accidents and malfunctions associated with shipping: - collision with marine mammals; ship engine failure at sea; ship grounding; ice /ship interaction; collision with other vessels; and major diesel spill at sea.*"
- but this list of topics is followed by sections

1.6.1 Collision with Marine Mammals
1.6.2 Ship Engine Failure at Sea
1.6.3 Cargo Ship or Ore Carriers Grounding without Fuel Spill
1.6.4 Fuel Tanker Grounding or Collision Causing Fuel Spill
1.6.5 Ice / Ship Interaction then
3.7 AIR TRAFFIC then
3.8 for major spills, where the reader is directed to three appendices.

The following path is not assisted by citation errors.

- Vol. 8:14 directs the reader to S. 2.5.2.2 for ballast water (BW) but it should be 2.6.2.2.
- Vol. 8:47 directs the reader to S. 3.4.2.3 for BW but it should be 3.5.2.3.
- Vol. 2:iii lists four figures in the volume but the first two are missing.
- There are many references to Enfotec 2010 without indicating it is an appendix.
- SD-EMMP-0010 is not listed in the master Table of Contents (ToC) but appears to be App. 10D-10.

Ice Thickness

35. App. 3F-1 (Enfotech 2010) indicates that the maximum ice thickness in Steensby Inlet is about 2 m (page 22) while the data presented in Fig. 20 indicate that 2 m is the most commonly recorded thickness (the mode) and the mean of these values is approximately 2 m (1.95). The text indicates that some measured thicknesses exceeded the maximum of 2 m and that, in fact, most measurements were around the 2 m mark. The next paragraph notes that at Hall Beach, ice thicknesses also run about 192 cm with some years exceeding 250 cm. Fig. 21 indicates they approached 3 m, similar to the real maximum recorded in Steensby Inlet. "*These thickness* [sic] *average…*" 5-10% greater than recorded at Pond Inlet. Fig. 6 indicates a mean annual thickness of about 155 cm with extremes about 195 cm so comparing mean to mean and maximum to maximum Steensby ice is 24-28% thicker than at Pond Inlet. Using the real maximum for Steensby and Hall Beach of 300 cm indicates that in an extremely heavy ice year in Foxe Basin, fast ice would be about 54% thicker than an extreme year at Pond Inlet. Ice thicknesses at Arctic Bay were not compared but are somewhat less than at Pond Inlet.

Local Study Area

36. The local study area (LSA) in Rev. Fig. 8-2.1 (Rev. Vol. 8) was reduced so that it fits within the Nunavut Settlement Area, yet Rev. Vol. 8 indicated that no changes had been made to the figure. Rev. Fig. 8-1.1 and 8-2.1 no longer match in terms of the extent of the LSA. The area marked as LSA in Rev. 8-2.1 closely matches the probable extent of year-round shipping in Fig. 8-1.1. In Fig. 8-1.1, the probable extent of year round shipping is a subset of the LSA.

Potential Accidents

37. Potentially catastrophic events are dismissed out of hand, as low probability (e.g., ships that remain on route are unlikely to run aground), and that serves as the basis for ignoring the higher probability of a ship running aground when it is not on the designated route. This example is further exacerbated by the fact that there is likely not going to be a designated route (see #10 Shipping Route) .The southern (Foxe Basin/Hudson Strait) shipping route seems problematic at best.